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Integral Field Near-IR Spectroscopy of a Sample of Seyfert and LINER Galaxies I: The Data[1]

Rafael M. Sosa-Brito, Lowell E. Tacconi-Garman, and Matthew D. Lehnert

Max-Planck-Institut für extraterrestrische Physik, Postfach 1312, 85741 Garching bei München, Germany

rmsb, lowell, mlehnert@mpe.mpg.de

and

Jack F. Gallimore

Department of Physics, Bucknell University, Lewisburg, PA 17837

jgallimo@bucknell.edu

ABSTRACT

We present near-IR integral field spectroscopy of a sample of 31 Seyfert and LINER galaxies which were selected both to span a wide range of nuclear magnitudes and to possess roughly equal numbers of Seyfert type 1 and 2 nuclei. Moderate resolution (R∼1000; R∼2000 for 3 cases) integral field K-band spectra were obtained for all 31 galaxies in our sample and for 18 galaxies (R∼1000; R∼2000 for 4 cases) H-band integral field spectra were also obtained. In each case, we present nuclear, larger aperture, and difference spectra with corresponding information about emission line wavelengths, fluxes, and widths. Line-free H- and K-band continuum images as well as [FeII]$\lambda 1.644\mu$m, Brγ, and H_2 1-0 S(1) emission lines are also presented. In addition, we provide extensive information about each galaxy obtained from the literature that will be useful subsequently for characterizing the sample and for comparison with our near-IR data.

Subject headings: galaxies: nuclei – galaxies: Seyfert – galaxies: photometry – infrared: galaxies: ISM: lines and bands

[1]Based on observations obtained with the Anglo-Australian Telescope, Siding Spring, Australia, the European Southern Observatory, La Silla, William Herschel Telescope operated on the island of La Palma by the Isaac Newton Group in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias, and the Calar Alto 3.5m which is operated by the Max-Planck-Institut für Astronomie, Heidelberg, Germany, jointly with the Spanish National Commission for Astronomy.

1. Introduction

Active galactic nuclei (AGN) show an array of phenomenology (e.g., Antonucci 1993; Krolik 1999, and references therein). They are prodigious producers of energy at all wavelengths and the reprocessing of their intrinsic emission and competing sources of emission often complicates the interpretation of their phenomenology. What pieces of their observed phenomenology is really intrinsic to the AGN and which are due to extinction, scattering, reprocessing, or competing phenomenon like the formation and evolution of massive stars? To determine the properties of the AGN implies that we must observe them over a wide range of wavelengths and at high spatial resolution to be able to spectrally and spatially segregate various emission mechanisms intrinsic to the AGN and those which are extrinsic, and thus competing, sources of emission.

Recent work has demonstrated that star-formation near the nucleus can contribute significantly to the optical–UV spectra of Seyfert nuclei. IUE spectra and HST imaging have been used to infer that only a fraction of the UV continuum observed in Seyfert 2 galaxies is actually due to a hidden AGN (e.g., Heckman et al. 1995; González-Delgado et al. 1998; Heckman et al. 1997). In red optical spectra of Seyfert 2 galaxies, Terlevich, Díaz, & Terlevich (1990) found that the equivalent widths of the Calcium triplet lines ($\lambda\lambda$8498, 8552, 8662) were similar to those in the bulges of normal galaxies. In a moderately large aperture near-IR absorption line study of a sample of Seyfert 1s and 2s, Oliva et al. (1999, 1995) have found that many Seyfert 2 galaxies show evidence for young or intermediate age populations while such populations are rare (or non-existent) in Seyfert 1 nuclei. But overall they find that both these young and old populations contribute significantly to the central near-IR emission from Seyfert galaxies.

Near-IR spectroscopy and imaging have a unique role to play in advancing our understanding of the AGN phenomenon. This role reveals itself in several important and unique aspects of near-IR data. First, the near-IR possess many emission lines and stellar absorption features that are useful for determining the age and metallicity of the nuclear stellar population (like the strong CO bandheads in the H- and K-bands; e.g., Schreiber 1998; Origlia, Moorwood, & Oliva 1993). Second, extinction by dust declines rather substantially from the UV through the optical out to the near-IR. Thus observations in the near-IR allow one to probe depths unreachable with data obtained at shorter wavelengths. Third, compared to the continuum generated by stars, confusing sources of emission due to the reprocessed emission from the AGN are also less significant in the near-IR. The emission from giant and supergiant populations peaks at about 1.6 μm and is thus easier for a moderately young ($> 10^7$ yr) population to dominate all other emission mechanisms in the near-nuclear environment, including reprocessing of nuclear continuum by dust (e.g. Ward et al. 1987), compared to the optical or UV wavelength regimes. In the UV and blue optical, the dust scattering efficiency is high enough and the recombination continuum strong enough to easily dominate the emission from the underlying stellar population. Thus even with high spatial resolution and/or heavy ob-

scuration diminishing the light from AGN might not be enough to allow one to investigate the stellar population of the nucleus unhindered by contamination from AGN emission at these wavelengths.

Taking advantage of these unique characteristics of near IR data with regards to investigating the stellar populations of active galactic nuclei, we undertook a comprehensive near-IR (H- and K-band) investigation of a large sample of Seyfert and LINER galaxies. This paper presents the resulting H- and K-band integral field spectroscopic data from our sample of 31 Seyfert and LINER galaxies. In addition to the strength of the near-IR data generally, integral field spectroscopy uniquely allows us to investigate the spatially resolved stellar populations of the nuclei of modest power AGN and to investigate the distribution of the near-nuclear emission line gas. Thus unlike most studies conducted to date on the near-IR nuclear properties of Seyfert galaxies, we do not have to exclusively rely on large entrance apertures to investigate these properties. The sample selection and characteristics is discussed in §2, the data reduction in §3, some of the results are briefly discussed in §4 and what is known in the literature about each of our sample galaxies is described in §5. We defer discussion of the emission line and stellar absorption line properties for now and limit ourselves to a description of the sample and how the data were obtained and reduced.

2. Sample Selection and Sample Characteristics

2.1. Sample Selection

The galaxies chosen for this program were selected to span as broad a range of nuclear magnitudes and optical line characteristics as possible and still be classified as Seyfert or LINER galaxies. These galaxies were selected from the compilation of Veron-Cetty & Veron (1996). However, due to limitations of the available observing time, the weather during the scheduled observing time, and the locations of the various observatories where the data were taken, the exact sample was a randomly selected subsample of our entire list of active galaxies. Our observed sample of galaxies is given in Table 1.

2.2. Spectral Classification of the Nuclear Emission

The initial classification criterion adopted to select our galaxies was to adopt the classical spectroscopic definition of a Seyfert nucleus, namely, a ratio [OIII]λ5007/Hβ>3. Overall, 22 of our observed sample fits this criterion and in fact, 16 galaxies have [OIII]/Hβ > 5 (see Table 2). However, six galaxies had an observed ratio lower than 3, and a further two did not have reliable measurements in the literature. Although these sources do not meet our strict selection criteria they are still useful for comparison purposes. Specifically,

these six are NGC 1672, NGC 1433, I Zw 1, Mrk 1044, Mrk 315, and NGC 7582, while NGC 4945 and Mrk 231 did not have reliable [OIII]/Hβ mesurements. These cases are discussed in more detail below.

After our initial selection, a more complete investigation of the nuclear spectral classification was conducted by searching the literature for line strength measurements. To make the classifications as robust as possible we searched for a wide variety of optical emission lines but principally focused on [OII]λ3727, Hβ, [OIII]λ5007, [OI]λ6300, Hα, [NII]λ 6583, and [SII]$\lambda\lambda$6716, 6731. Our specific selection of the lines to search for was based on the criteria outlined by Baldwin, Phillips, & Terlevich (1981) and Veilleux & Osterbrock (1987). To make the comparison of the emission lines and line ratios as fair as possible, we tried where possible to ensure that the same apertures and slit position were used for all lines and checked for uniform reddening correction of the emission line ratios. Further, they were checked to be approximately corrected for the effects of underlying absorption in the line strengths. Finally, we sought uniform measurements of the emission line widths to distinguish between Seyfert 1s and 2s. While these were our goals, due to a lack of data some compromises had to be made. In most cases, these measurements are internally consistent but not uniform across the entire sample (e.g., the apertures are not the same from galaxy to galaxy).

To classify our galaxies, our compilation of optical emission line ratios was used together with diagnostic criteria from Baldwin, Phillips, & Terlevich (1981) and Veilleux & Osterbrock (1987). For almost all of the galaxies in our sample the available data allows us to determine their position in at least two of the diagnostic diagrams. In those cases where the resulting classification differs from one diagram to the other, greater weight was given to the classification derived from the [OIII]λ5007/Hβ *vs.* [NII]λ6583/Hα (Figure 1) and [OIII]λ5007/Hβ *vs.* [SII]$\lambda6716+\lambda6731$/Hα diagrams, as these lines are strong, and the ratios are only marginally affected by reddening. The diagrams involving [OII]λ3727/[OIII]λ5007 and [OI]λ6300 were given a lower weight owing to the strong reddening uncertainties in the former case, and the relative weakness of the line in the latter case.

In Table 2 we show the values for the ratios (corrected, with few exceptions, for reddening and underlying stellar absorption), over a range of apertures typically of the order of a few arcseconds centered on the nucleus. The Seyfert type is chosen as 1, 1.5 or 2 according to the width of the hydrogen lines. We opted not to further subclassify our sample. A classification of Seyfert 1.5 was chosen when clear signs of underlying broad component on a narrow line was found on the literature. In cases of doubt the conservative route was taken and the galaxy was designated as either a “pure” Seyfert 1 or a “pure” Seyfert 2. Widths broader than about 1200 km s^{-1} were chosen for the classification as type 1, less than about 800 km s^{-1} for type 2. Between those two values we used the narrowest and broadest measured line width to “tip the balance” to one class or the other. Our final classifications are provided in Column 8 of Table 2.

There are a few sources which did not meet our original [OIII]λ5007/H$\beta > 3$ selection criteria. In the cases of NGC 1433 and NGC 1672, our adopted classification is LINER (see Heckman 1980, and §§5.11 and §§5.13, respectively). I Zw 1 and Mrk 1044 have properties and line ratios like "Narrow-Line Seyfert 1s" (NLS1) and we adopt this classification (see §§5.2 and §§5.4, respectively, for details)[2]. Mrk 315 and NGC 7582, on the other hand, show strong signs of harboring Seyfert nuclei but probably also host significant starbursts which greatly affect their nuclear emission line properties (see §§5.30 and §§5.31). For those cases we have adopted the classifications of Seyfert 1.5/HII and Seyfert 2/HII, respectively. The classification of NGC 4945 is particularly controversial. A vigorous debate is underway about whether or not NGC 4945 harbors an AGN. For Mrk 231 no line ratios are listed, anyway, the Seyfert 1 classification was adopted based on the information available in the literature. These arguments are discussed in more detail in §5.

Overall, our sample contains approximately equal numbers of Seyfert 1s and 2s, with a few LINERs or possible LINERs. Thus our final sample meets our competing goals of comparing the near-infrared characteristics of active galaxies over a broad range of nuclear magnitudes, optical emission line properties, and X-ray properties (which means some "weak AGNs" like LINERs should be included) and providing a robust comparison between Seyfert 1s and 2s (i.e., roughly equal numbers should be observed).

2.3. Adopted Distances

Since we are interested in comparing the physical properties of these galactic nuclei in detail, the distances adopted in this paper require discussion. For the most distant galaxies, a simple Hubble distance (D(Mpc) = V_{3K}/H_0) after correcting the observed recession velocities to the microwave background restframe (V_{3K}) was adopted. A value for H_0 of 75 km sec^{-1} Mpc^{-1} was adopted for this work, and the observed heliocentric velocities (taken from the RC3 (de Vaucouleurs et al. 1991)) have been corrected following the work of Lineweaver et al. (1996). From COBE observations, Lineweaver et al. (1996) find the velocity of the background dipole to be 369 ± 2.5 *km sec*$^{-1}$ towards $\alpha = 11^h 11^m 57^s \pm 23^s$, $\delta = -7\overset{\circ}{.}22 \pm 0\overset{\circ}{.}08$ (J2000). Thus,

$$V_{3K} = V_{obs} + 76.2\,\cos\delta\sin\alpha - 358.1\,\cos\delta\cos\alpha - 46.4\,\sin\delta\,, \quad (1)$$

where V_{3K} is the velocity relative to the microwave background, V_{obs} is the observed heliocentric velocity, and (α,δ) are the J2000 coordinates of the source. The velocities in the microwave background frame are listed in Table 1.

[2]It has been suggested (Ho et al. 1997) that NGC 4051 likely belongs to the NLS1 class, but we prefer the classification of a classical Seyfert 1.

Of course, correcting for the solar peculiar velocity is only appropiate for sources that are in the Hubble flow. For example, for galaxies with peculiar velocities as large as that derived for the correction between heliocentric and microwave background frames would imply an error of ± 5 Mpc. Since such an uncertainty would be significant for galaxies within about 20 Mpc, we have searched for independent distance estimates for galaxies within 20 Mpc with which to compare with our simple Hubble law distances. Our adopted distances and the sources for those distances are presented in Table 1. The mean adopted distances of our sample (see §§2.2) are 84 ± 26 Mpc, 47 ± 19 Mpc, and 53 ± 17 Mpc for Seyfert classes 1, 1.5, and 2, respectively. Taken as a combined class, Seyfert 1 and 1.5 galaxies in our sample have a mean distance of 68 ± 17 Mpc, in fair agreement with that of the Seyfert 2 galaxies.

2.4. Morphological Classification

As one of the goals of this program is to study the nuclear regions of Seyfert galaxies, we would therefore like to investigate how the properties might depend on galactic morphological type. The morphological classifications are taken from RC3 (de Vaucouleurs et al. 1991). Special care should be taken when using the classifications of the more distant galaxies since the photographic plates on which the RC3 classification was based can be biased against structures on the furthest galaxies. For completeness, the RC3 morphological types are shown in Table 1.

3. Observations and Data Reduction

3.1. 3D and ROGUE

Imaging spectroscopy of the sample of Seyfert galaxies was obtained using the MPE NIR imaging spectrometer 3D. Details of 3D are given by Weitzel et al. (1996), and only a brief summary is presented here. 3D uses a mirror image slicer to divide a square field-of-view into 16 slitlets, each 1 pixel wide and (roughly) 16 pixels long (see §3.3), which are subsequently arranged end-to-end in a staircase pattern to produce a long pseudo-slit. This has the effect of reducing the two spatial dimensions down to a single dimension. This pseudo-slit is then spectrally dispersed by passing it through a grism. The final, two-dimensional projection of the three dimensional (two spatial, one spectral) data is imaged onto a 256×256 pixel NICMOS III detector.

3D has a suite of 5 grisms, two of which can be used on any given observing run. The wavelength range and achieveble resolution for these grisms are listed in Table 3. Prior to 1995 the data were sampled at somewhat less than the Nyquist frequency, resulting in spectral resolutions $\sim 25\%$ lower than those listed in Table 3. After that date, a piezo-

driven mirror was implemented which is used for half-pixel spectral dithering to realize the full resolution provided by the grisms.

Starting in July 1994, 3D was used in conjunction with a tip-tilt corrector ROGUE (Thatte et al. 1995). This allowed us to achieve spatial resolutions which were considerably better than the longterm seeing values. In addition, ROGUE carries with it a pixel scale changing feature which allows observers to take full advantage of changing seeing conditions. The pixel size for all observations (including those prior to July 1994) ranged from $0.25''$ to $0.5''$ resulting in fields-of-view between $4''$ and $8''$ and which depended on the seeing conditions and on which telescope the observations were taken.

3.2. Details of the Observations

Data were collected from November 1993 until April 1999 on various telescopes located in both the northern and southern hemispheres. Most of the data presented here were taken using the Anglo-Australian Telescope. Tables 4 and 5 summarize the circumstances of the observations. The spatial resolution listed in Table 5 is that achieved through the use of ROGUE, and represents a lower limit to the actual NIR seeing at the time of the observations.

In a typical observation, the telescope was pointed alternatively to the object and the sky in the pattern sky-object-object-sky. Within this pattern, half-pixel spectral dithering is performed between the two object exposures. As each on source exposure receives all the flux, the total integration times listed in Table 5 are the sum of all of the individual on source exposure times. The time per individual exposure was governed by our ability to successfully subtract the sky emission from the source exposures. Thus, H-band exposures were typically 60 seconds long, while K-band times ranged between 100 and 140 seconds, depending on atmospheric conditions.

Since both the H- and K-bands are strongly contaminated by telluric absorption, observations of stars with featureless, or weak-lined, spectra in the H- and K-bands were observed to calibrate away the atmospheric lines. Typically, for H-band measurements early type dwarfs or early F-type dwarfs were used, while for K-band observations late-F or early-G dwarfs were used. These calibrators were observed every 0.5–1 hour, depending on sky stability and the zenith distance of the observations.

Most of our targets were observed for long periods during one or more nights and all of these data were reduced independently for each night of observation.

Flatfield frames were taken usually at the beginning and/or at the end of the night. Dome flats and internal lamp flats were taken, the first consisting of exposures of an illuminated portion of the dome, the latter consisted of exposures of a incandescent tungsten filament whose spectral shape was easily removed from the data. In practice,

the dome flats often had a spectral emissivity that was flat enough to provide a reasonable flatfield and were often used exclusively to flatfield the data. Otherwise, combinations of internal and dome flats were used to flatfield the data. Exposures of an argon and neon arc lamps were made to provide wavelength calibration of the H- and K-band respectively. These wavelength calibration exposures were taken every night and the final wavelength calibration were checked against the wavelengths of strong obvious night sky lines. Dark exposures were obtained usually at the end of each run, in order to remove the (small) dark current contribution for each data frame.

3.3. Data Reduction

The data were reduced using the GIPSY package (van der Hulst et al. 1992), with additional 3D-specific routines which were written in-house. The data were first corrected for (small) deviations from linear response before subtracting the sky exposures from their corresponding object frames.

The sky-subtracted source frames are flatfielded, and dead pixel corrected. At that point the individual spectrally dithered pairs are interleaved and the resulting frame is wavelength calibrated, using calibration files generated from the arc lamp exposures. From these two dimensional representations of three dimensional information data cubes are then generated. The non-integer slitlet lengths require spatial re-alignment by fractions of a pixel to obtain useful data cubes. Sub-pixel interpolation is done using Fourier interpolation for spatially well sampled data or by quadratic interpolation for less well sampled data.

The data cube is then resampled onto a finer grid scale for more precise centering of individual source frames with respect to each other. The pixel representing the center of each frame is chosen to be the peak pixel within a broadband image (i.e. an image generated by collapsing the cube). The fine-tuning of the peak position is then achieved by assuming that the flux distribution very near the peak is Gaussian in nature and the shifting the image such that the peak of a fitted Gaussian lies at its center. The set of re-registered source frames are then combined into a final data cube.

The final reduction step is to remove the telluric absorption from the object spectrum. The data for the atmospheric calibrator are reduced in exactly way as for the object. The extracted one-dimensional spectrum of the atmospheric calibrator is divided into the object data cube.

Calibration was done by using aperture magnitudes available from the literature (see Table 5) and appropriately scaling our spectra extracted over the same projected aperture.

4. Results

We defer a detailed analysis of the full set of data to later papers. Here we would like just to characterize the quality and gross features of the data set.

Having three dimensional data for a large number of Seyfert galaxies allows us access to a variety of diagnostic display methods. The first of these methods is one in which aggregate spectra over some portion of the source are generated . For example, a seeing-weighted combination of individual spectra within the cube centered on the H- or K-band continuum peak can be made. Figure 2, shows 3 spectra for each galaxy: one seeing-weighted, one which is the sum of the data within an aperture of diameter $3''$ or $4''$ centered on the H- or K-band peak continuum emission and another one which is the difference between the larger aperture and the seeing-weighted spectra. In each case, the apertures chosen were determined by the seeing during the observations and/or the field-of-view of the data. For those cases where the field is dominated by a strong central pointlike source, the seeing weighted spectrum can be regarded as the "nuclear spectrum." Measured fluxes of strong H- and K-band emission lines, as well as broadband fluxes, derived from the nuclear spectra, spectra of data within a $2''$ diameter aperture (not shown), and the larger aperture (either $3''$ or $4''$) spectra are provided in Tables 6, 7, and 8.

Surprisingly, about half of the nuclear spectra are in fact dominated by the stellar population of the nucleus, and not by the AGN continuum. The fraction of galaxies whose nuclear spectra are dominated by a "diluting continuum" (relative to the stellar absorption line strengths) is a function of Seyfert type, with Seyfert 1s preferentially showing more dilution. However, both Seyfert 1s and 2s exhibit highly diluted nuclear spectra (e.g. NGC 1068, a Seyfert 2) and both classes also exhibit nuclear spectra that are dominated by their underlying bulge populations (e.g. NGC 1566, a Seyfert 1). The equivalent widths of the emission lines in most of the nuclei are very low (Brγ equivalent widths are rarely above 10Å). However, those nuclei with high Brγ equivalent widths are preferentially Seyfert 1s. Many of the galaxies have blue continua in both the nuclear and large aperture spectra suggesting that they are dominated by stellar continuum emission, which must not be heavily extincted.

The second means of looking at the data involves collapsing it spectrally, either over the entire band (either with or without the inclusion of lines) or over a line (with or without the inclusion of local continuum). In Figure 3 we present the spatially resolved maps of the H- and K-band continua, and emission line maps of [FeII]$\lambda1.644\mu$m, H_2 (including all detected H_2 lines in the K-band), and Brγ. The continuum maps were constructed by excluding strong emission lines ([FeII] in the H-band, Brγ and H_2 lines in the K-band). In addition, the K-band images include only wavelengths shortward of the CO bandheads at 2.29 μm. Thus, these are "continuum only" images. The [FeII]$\lambda1.644\mu$m, H_2, and Brγ emission line maps were constructed by including only those spectral channels that

included significant line emission. The line maps have been continuum-subtracted. In addition, the line maps have been spatially truncated such that only those pixels that are $> 3\,\sigma$ above zero are included in our plots. Each map shows data for which we are confident that the displayed morphology is statistically significant. Thus images not displayed for [FeII] (when H-band data were available), Brγ, or H_2 for any galaxy implies that the source lacked significant emission in those lines or that the signal to noise ratio was not good enough to create an image. The H- and K-band continuum maps display the entire spatial dimensions of the data cube and have not been truncated in size.

There is a wide range of morphologies in emission line maps, from point like sources to more extended diffuse sources. Interestingly, in the continuum maps there are also a wide range of morphologies in the sense that some images are obviously dominated by emission from a point source, while other tend to be more diffuse and have no evidence for harboring a point source. A comparison of an aperture spectra and continuum maps reveals that those sources with evidence for strong point source emission also show diluted stellar continuum. The presence of a nuclear point source is a function of the Seyfert type, but some Seyfert 1's showing no such point source and some Seyfert 2's exhibiting strong evidence for a point source. This is similar to what was found when considering the degree to which the nuclear spectra were diluted. The distance distribution of Seyfert 2s is similar to that of Seyfert 1s and 1.5s (see §§2.3), thus this result is independent of any distance bias of the object types.

5. Notes on Individual Objects

In this section we provide a brief synopsis of the observational characteristics of each object within our study as gleaned from the literature, focusing particularly on the circum-nuclear properties of each galaxy. Special emphasis was given to other near-IR observations and other direct evidence for the existence and properties of the active nucleus.

5.1. Mrk 348 (=NGC 262 = UGC 499)

This galaxy hosts a Seyfert 2 nucleus with strong emission lines and underlying featureless continuum in the optical (Koski 1978). The host galaxy is an early-type spiral galaxy which is oriented nearly face-on and has a nearby companion galaxy, NGC 266 (Heckman et al. 1982; Simkin et al. 1987). A broad Hα component has been found in polarized light with a FWHM of 8400 km s^{-1} (Miller & Goodrich 1990). Veilleux, Goodrich, & Hill (1997) do not find broad Brγ in their IR spectrum but find Brγ profile broader than that of H_2 1-0 S(1). Our K-band spectrum superficially agrees with theirs although the lower S/N of our spectrum does not permit more conclusive comparisons. A

hard X-ray detection (Awaki et al. 1991) gives $N_H = 1.1 \pm 0.2 \times 10^{23}\,cm^{-2}$ and supports the idea that Mrk 348 harbors an obscured Seyfert 1 nucleus. Neff & de Bruyn (1983) report that its nuclear radio source consists of a compact core plus two knots aligned along position angle 168°, with a total size of about $0\farcs15$. They also report variation at 6 and 21 cm on timescales of months. A high resolution HST image published by Capetti et al. (1996b) shows a linear structure of the emission in narrow-band [OIII]λ5007 emission extended $0\farcs45$ at a position angle of $\sim$155°.

5.2. I Zw 1

I Zw 1 is sometimes classified as "narrow-lined Seyfert 1" (NLS1) galaxy, due to its exhibiting a strong narrow component in some of its broad emission lines (Osterbrock & Pogge 1985). In addition, its high optical luminosity ($M_V = -23.8$) is often used to claim that I Zw 1 is the "nearest QSO." It has high X-ray luminosity (Kuper, Canizares, & Urry 1990) and strong optical FeII emission lines (Halpern & Oke 1987) which are also typical of NLS1s. Schinnerer, Eckart, & Tacconi (1998) find a strong presently decaying starburst located in a circum-nuclear ring ($1\farcs5$ diameter) which contributes a large fraction of the total (near-)nuclear light. The optical emission line ratios (see Table 2) also indicate the presence of significant star-formation and its composite starburst/AGN nature (we adopt the classification of NLS1/HII). Hutchings & Crampton (1990) find that its host galaxy is a nearly face-on spiral with a fainter companion to the west.

5.3. Mrk 573 (=UGC 1214)

Mrk 573 is a Seyfert 2 galaxy showing strong high-ionization emission lines (Koski 1978; Tsvetanov & Walsh 1992). No hard X-ray flux was detected by *Ginga* for this galaxy (Smith & Done 1996). Veilleux, Goodrich, & Hill (1997) find that the nuclear near-IR emission from Mrk 573 is dominated by stars with faint Brγ and H_2 1-0 S(1) emission. Our spectrum shows similar characteristics with a strong stellar contribution and lack of significant diluting continuum. The bar within a bar, shown, for example in the K-band image of Alonso-Herrero et al. (1998) (change from PA $\approx$ 0° -10° in the outer to PA $\approx$ 80°-90° in the inner isophotes at $4\farcs5$ of the center) is also seen in our K-band image but our field-of-view is too small to see the larger-scale bar. Tsvetanov & Walsh (1992) find a biconical radiation field roughly aligned with radio emission axis of Mrk 573 found by Ulvestad & Wilson (1984a). Pogge & de Robertis (1995) present high quality line maps, which in [OIII], for example, show clearly a biconical shape. They also find two pairs of arclike emission line features that enclose the nucleus. The innermost of them are within 2″ of the nucleus, which they interpret as bow shocks. Unfortunately, our line maps are of insufficient signal-to-noise to reveal any possible biconical emission

in Brγ or H_2 1-0 S(1).

5.4. Mrk 1044

Mrk 1044 is a NLS1 (see Osterbrock & Pogge 1985) and it shows some evidence for weak variability in its X-ray emission (Boller, Brandt, & Fink 1996). It has strong Balmer lines and the ratio I[OIII]/I(Hβ) (1.67) is uncharacteristically low for the narrow line region of a Seyfert galaxy. However, such a low ratio is typical of objects classified as NLS1 (Osterbrock & Pogge 1985). Rodríguez-Pascual, Mas-Hesse, & Santos-Lleo (1997) observe a narrow (FWHM = 2410 km s^{-1}) and a broad (FWHM = 10900 km s^{-1}) component in Lyα, the narrow linewidth being compatible with our Brγ measurement. Rafanelli & Schulz (1983) obtained optical spectra and B-band imagery of Mrk 1044. They observe a compact object in their B image, FeII optical emission lines as well as Balmer emission lines with faint broad component of FWHM = 3400 km s^{-1} and with a narrower component superimposed. A dominant unresolved nucleus is observed by Nelson et al. (1996) with the HST in the near-IR, as is also the case in our H- and K-band images.

5.5. NGC 1068

NGC 1068 is the nearest Seyfert 2 galaxy and has been very extensively studied. NGC 1068 has a polarized optical spectrum similar to that directly observed in Seyfert 1 nuclei, with FWZI $\approx$ 7500 km s^{-1} for the Balmer lines (Antonucci & Miller 1985). A compact stellar cluster has been found by Thatte et al. (1997) and they show that its contribution to the total bolometric nuclear (within a radius $2''\!.5$) luminosity is at least 7%. They also observe that 94% of the light in the K-band in the central $1''$ originates from a compact source which they interpreted as hot dust emission. The [OIII] line emission morphology has a conical shape which extends $7''\!.5$ at PA 35° with opening angle 45° (Evans et al. 1991). A ring of star formation (of outer diameter $36''$) apparently powers half of the mid-/far-IR luminosity while the other half comes from the Seyfert nucleus (Pogge & de Robertis 1993). Significant amounts of hot dense molecular gas is shown by the H_2 1-0 S(1) line emission extending over a region of 350 pc around the nucleus (Rotaciuc et al. 1991; Blietz et al. 1994) and thought to be excited in the gas heated by UV radiation or by X-ray photons from a central source (Rotaciuc et al. 1991). Weak H_2 1-0 S(1) line emission, possibly due to shock excitation, also extends for $10''$ along the stellar bar (Davies, Sugai, & Ward 1998; Scoville et al. 1988). Our H_2 1-0 S(1) line map agrees very well with the bright inner regions of the map from Davies, Sugai, & Ward (1998) (see their Figure 4). The [FeII]$\lambda 1.644\mu$m forbidden line has been mapped (Blietz et al. 1994) and compared to the structure of the radio elongated emission (Wilson & Ulvestad 1983). The [FeII]$\lambda 1.644\mu$m and radio emission line are co-linear, with the

lobes of the radio emission “flaring out” at the end of the significant [FeII]$\lambda 1.644\mu$m emission. Forbidden [SiVI]$\lambda 1.962\mu$m line has been detected (Oliva & Moorwood 1990) in this object, however in our spectrum this spectral region is not covered. Elvis & Lawrence (1988) present EXOSAT observations in the 2–10 keV range. They detect a source with a flat power law spectrum which resembles that of typical Seyfert 1 galaxies. Within their observations they do not find evidence of variations on timescales of 30 minutes to 4 years. They use this as evidence that the direct view of the nucleus is totally obscured and the X-ray flux observed is seen only in scattered light.

5.6. NGC 1097 (=Arp 77)

NGC 1097 was classified originally as LINER on the basis of its optical spectra (Keel 1983), but Storchi-Bergmann, Wilson, & Baldwin (1996a) re-classified it as a Seyfert 1 galaxy after observing the appearance of broad Balmer line emission and a featureless blue continuum. Brγ nuclear emission is not detected by Kotilainen et al. (2000) or in our spectrum of the nucleus, while H_2 emission is prominent in their spectrum as well as ours. In the K-band image of Kotilainen et al. (2000) a ring-like structure 10″ from the nucleus (outside our field-of-view) is clearly seen. This region corresponds to a ring of active star-formation and appears to be located between two inner Lindblad resonances (see also Storchi-Bergmann, Wilson, & Baldwin 1996a). Pérez-Olea & Colina (1996) present high resolution *ROSAT* X-ray image of the nucleus and found that the circum-nuclear ring accounts for 20% of its total X-ray luminosity. Hard X-ray emission from a point-like source is reported by Iyomoto et al. (1996) suggesting the existence of a low-luminosity AGN. The nucleus of NGC 1097 also exhibits a complex system of jets discovered by Wolstencroft & Zealey (1975) which are 15″ wide and extend 5–19′ from the nucleus.

5.7. NGC 1194 (=UGC 2514)

This Seyfert 1 galaxy has been little studied and thus not much is known about it. NGC 1194 is a highly inclined spiral galaxy (Nilson 1973). A diffuse stream of gas towards the nearby companion galaxy UGC 2517 (Nilson 1973) suggests a recent encounter. It has warm IRAS 25–60 micron color (Kailey & Lebofsky 1988; de Grijp et al. 1992). Our K-band spectra is noisy and no emission lines are detected, but CO absorption features are indeed present and the continuum is red compared to that expected from a population of giants or supergiants probably indicating either significant extinction to the circum-nuclear stellar population or hot dust emission from the active nucleus. Our K-band image is consistent with NGC 1194 having a dominant central point-like component with an underlying, more extended component. These observations were, however, obtained under quite poor seeing conditions and the quality of our data is low.

5.8. NGC 1275 (=Perseus A)

NGC 1275 is the central galaxy of the Perseus cluster with an optically luminous nucleus which has been re-classified by Veron (1978) as a BL Lac object due to its weak line emission spectrum and to the absence of broad lines as well as the variability and polarization of its nucleus. However Ho et al. (1997) report a broad Hα component with FWHM 2750 km s^{-1} and extremely wide wings (FWZI 19000 km s^{-1}) and we adopt the classification of Seyfert 1.5/LINER (see Table 2). Rothschild et al. (1981) observed that the active nucleus is a hard X-ray source and it is variable on timescales of about one year. Intra-night micro-variability in the optical has been observed (Pronik, Merkulova, & Metik 1999). NGC 1275 has a jet (Marr et al. 1989; Dhawan et al. 1990; Pedlar, Booler, & Davies 1983; Pedlar et al. 1990) and counterjet (Vermeulen, Readhead, & Backer 1994) radio morphology. NGC 1275 is also cooling flow galaxy (see, e.g. Heckman et al. 1989). This galaxy has been studied in the near-IR by Krabbe et al. (2000) who find that its near-IR properties can best be described as a combination of dense molecular gas, ionized emission line gas, and hot dust emission concentrated on the nucleus (our spectra are red and show significantly diluted stellar absorption features). Kent & Sargent (1979) studied its two velocity systems and conclude that probably the high-velocity emission line system (8200 km s^{-1}, several arcsec northwest of the nucleus) is excited by hot stars while the low-velocity filamentary emission line structure (5300 km s^{-1}, the systemic velocity of NGC 1275) can be explained by either shocks or photoionization from the Seyfert nucleus. There is also a central population of young massive star clusters (Holtzman et al. 1992), roughly 15 of which lie within our field-of-view.

5.9. NGC 1365

NGC 1365 is a spiral barred galaxy located in the Fornax cluster. It exhibits a conical [OIII] emission morphology (Kristen et al. 1997), and shows starburst activity (e.g., Telesco, Dressel, & Wolstencroft 1993) with star forming regions concentrated in "hot spots" around the nucleus, outside of our field-of-view. Kristen et al. (1997) observed this galaxy with the FOC onboard HST and detected numerous bright super star clusters associated with the circum-nuclear star forming regions (Stevens, Forbes, & Norris 1999). Risaliti, Maiolino, & Bassani (2000) observed NGC 1365 with *BeppoSAX* and found its 4–10 keV emission to be highly variable over the course of the observations (varying by a factor of 2 over 50,000 seconds). Broad hydrogen emission lines have been seen on the nucleus (see for example Schulz et al. 1999; Edmunds & Pagel 1982) indicating the presence of an AGN. Our data also shows a broad nuclear Brγ line, together with a red continuum with relatively weak stellar absorption features. VLA observations (Sandqvist, Joersaeter, & Lindblad 1995) reveal a radio jet from the nucleus in the direction of the optical emission line cone.

5.10. NGC 1386

The presence of the AGN in this galaxy is revealed by both water maser emission and their associated velocities (Braatz et al. 1997), as well as by a strong Fe-K emission line seen in *ASCA* observations (Iyomoto et al. 1997). An infrared excess is observed in the L- and N-bands (Sparks et al. 1986) but not in the J-, H- and K-bands. Our K-band spectra shows little evidence for a continuum diluting the relatively strong stellar absorption features. Speckle Hα observations show an elongated structure $\sim 3''$ long (centered on the nucleus) along a position angle of $\sim 30°$ consisting of several knots (Mauder et al. 1992). Our broadband H- and K-band maps do show similar elongation to that found by Mauder et al. (1992). Ulvestad & Wilson (1984b) found that the morphology of the nuclear radio continuum is extended towards the southwest along galaxy major axis (PA 55°) by about 400 pc. Evidence for nuclear outflow along the same axis is found by Weaver, Wilson, & Baldwin (1991).

5.11. NGC 1433

NGC 1433 has been classified as Seyfert 2 (Veron-Cetty & Veron 1986) but we prefer to classify it as a LINER on the basis of its emission line ratios from the literature (Table 2). No direct sign that NGC 1433 harbors an AGN has been found, but it does possess a rich morphology with two bars with position angles which differ by 64° (Buta 1986) and three concentric rings, the most inner one of $18''$ diameter (Buta 1986). Jungwiert, Combes, & Axon (1997) detected the inner bar in the near-IR which is seen in our images with a similar morphology. HII regions are observed along the inner ring (Buta 1986), but this region lies outside of our field-of-view. Harnett (1987) found in their radio observations that the radio emission peaks on the position of the optical nucleus and that weaker radio emission extends along the large scale bar.

5.12. NGC 1566

This galaxy possesses weak emission lines for a Seyfert (Osmer, Smith, & Weedman 1974). HST WF/PC1 observations of NGC 1566 made by Kriss et al. (1990) show that the emission line gas has a point source contribution with a component that extends to $<0\farcs7$, while subsequent HST continuum imagery reveals spiral dust lanes within $1''$ of the nucleus (Griffiths et al. 1997). Its optical spectrum is that typical of a Seyfert 1 galaxy (Kriss et al. 1990). However according to Hawley & Phillips (1980) its nuclear spectra resembles more that of an HII region than that of a Seyfert galaxy except for the broad emission wings at Hα. A strong X-ray point source with weaker extended emission was found through *ROSAT* observations (Ehle et al. 1996). Multi-wavelength nuclear variability (from X-ray to near-IR) has been reported by Baribaud et al. (1992) with

X-ray emission variations up to 40% within timescales less than a month. A prominent large scale bar is seen in near-IR images (Hackwell & Schweizer 1983). Both large scale and nuclear radio emission is seen in NGC 1566 (Harnett 1984, 1987).

5.13. NGC 1672

We adopt for this galaxy, based on the line ratios from the literature, a classification of LINER galaxy. NGC 1672 shows X-ray emission from the ends of its prominent bar, from two other off-nuclear regions, and from an extended nuclear source (de Naray, Brandt, & Halpern 1999; de Naray et al. 2000). The nuclear emission, which is the dominant soft X-ray source, shows no variability (de Naray et al. 2000). de Naray et al. (2000) note that the bulk of the 2–10 keV and 5–10 keV comes from the off-nuclear source X-3. Further, they do not find evidence for an absorbed nuclear X-ray source and conclude that if NGC 1672 harbors a luminous Seyfert nucleus, it must be obscured even in the X-rays (requiring column densities $> 2 \times 10^{24}$ cm^{-2}). Hα knots are found in a ring structure within $10''$ of the nucleus, which is likely to be a region of recent star-formation (Evans et al. 1996). The velocity field around the nucleus indicates a 9×10^8 M$_\odot$ within the inner $1\farcs8$ (Díaz et al. 1999) which is suggestive of a heavily obscured AGN (but is certainly not conclusive). Marconi et al. (1994) detect H_2 1-0 S(1), H_2 1-0 S(3) but no [SiVI]λ1.962μm in their K-band spectrum. Our K-band spectrum shows no H_2, despite our achieving a noise level more than a factor of three lower than that of Marconi et al. (1994).

5.14. Mrk 1095 (=UGC 3271 = Ark 120)

The nucleus of Mrk 1095 exhibits a typical Seyfert 1 spectrum (Rafanelli & Schulz 1991) whose optical continuum and emission line show variability over times scales of years (Peterson et al. 1998). A dominant unresolved nucleus is reported on HST observation by Nelson et al. (1996). The 3D data shows very broad Brγ emission centered on the nucleus and a very red spectrum. The latter can be interpreted as hot dust emission diluting the stellar continuum. This is in qualitative agreement with Oliva et al. (1999), who use a technique of fitting stellar template spectra to restricted portions of the H- and K-band spectra and report stellar contributions of 50% and 25% at 1.62 μm and 2.29 μm, respectively.

5.15. NGC 2110

HST imaging spectroscopy of this source reveals both a narrow, $1''$ long jet/region of [OIII] emission extending to the north of the nucleus and an S-shaped Hα emission region

within the inner 4″ (Mulchaey et al. 1994). A similar S-shaped morphology is seen in our [FeII] map. Radio emission extends symmetrically $\sim 2''$ north and south of the nucleus (Ulvestad & Wilson 1983) while [OIII] and Hα+[NII] images show more extended emission which is also elongated north-south (Wilson, Baldwin, & Ulvestad 1985; Pogge 1989). Hard X-ray observation of its nucleus are consistent with an obscured Seyfert 1 nucleus (Malaguti et al. 1999). Quillen et al. (1999) imaged NGC 2110 with NICMOS and find the molecular hydrogen emission to be extended. In agreement with these data are those of Storchi-Bergmann et al. (1999), who observed NGC 2110 with a long slit in the near-IR and found extended [FeII]$\lambda 1.257\mu$m and H_2 1-0 S(1) emission. Our data lack sufficient signal-to-noise to see extended H_2 1-0 S(1) emission. Storchi-Bergmann et al. conclude that an important source of exitation for [FeII]$\lambda 1.257\mu$m may be shocks driven by the radio jet and while the H_2 is excited by the central X-ray source. They report that the dynamical center is displaced with respect to the peak of near-IR continuum and find signatures of hot dust emission (in agreement with our K-band spectra).

5.16. NGC 3079

NGC 3079 is a nearly edge-on galaxy (our K-band image is also elongated at the same position angle as the galactic disk) which has been well studied. NGC 3079 has been classified as a LINER (Heckman 1980), but we prefer a Seyfert 2 classification based on line ratios from the literature (Table 2). Lehnert & Heckman (1996) and Veilleux et al. (1994) find evidence that the nucleus is driving a galactic-scale outflow (a "super-bubble"). On the nucleus, large concentration of CO gas has been found (Schoniger & Sofue 1994) and a central starburst appears sufficiently strong to produce the outflow (Veilleux et al. 1994), though the latter authors cannot exclude the presence of an AGN. A detection of broad Hα, consistent with the nuclear outflow, has been reported by Stauffer (1982). Israel et al. (1998) image the central region of this galaxy in the near-IR (J, H, K and the H_2 1-0 S(1) line). They claim that its extremely red infrared colors can only be explained with hot dust emission, and support that argument by comparing the depths of the K-band CO absorption lines from Hawarden et al. (1995) with those from Arnaud, Gilmore, & Collier (1989) and Lançon and Rocca-Volmerange (1992). Israel et al. (1998) infer based on this comparison that up to 25–30% of the emission within the central $3'' \times 3''$ can be attributed to hot dust. However, our K-band spectrum, at higher spectral resolution than that by Hawarden et al. (1995), shows CO depths 25–30% deeper than theirs, and thus does not reveal a hot dust signature. Hawarden et al. (1995) conclude that the H_2 near-IR emission lines are shock excitated in the outflow and that the outflow has an active nuclear origin. Pietsch, Trinchieri, & Vogler (1998) resolve the X-ray emission from the inner $20'' \times 30''$ and find it to be coincident with the optical super-bubble. A point-source active nucleus may contribute to the X-ray emission. In addition, they argue that an AGN interpretation is favored for the high X-ray to optical

luminosity ratio.

5.17. NGC 3227 (=Arp 94)

NGC 3227 is classified as Seyfert 1.5 and is interacting (see e.g. Mundell et al. 1995b) with NGC 3226, a dwarf elliptical companion. Mundell et al. (1995a) obtained ground based [OIII] imaging showing an extended ($7''$ to the NE of the nucleus, PA $\approx 30°$) structure non-aligned with their radio map (6 and 18 cm) showing a $0\farcs4$ double radio source at PA $\approx -10°$ (the difference in position angles between the radio and optical structures is $\sim$40°). Schmitt & Kinney (1996) present an archival [OIII] HST image made with a shorter exposure time than that by Mundell et al. (1995a) showing a compact nucleus and extended ($0\farcs9$) emission (PA 15°). Arribas & Mediavilla (1994) present results of 2-dimensional optical spectroscopic observations of the inner kiloparsec of this galaxy showing both AGN and HII region-like emission line properties. NGC 3227 shows strong spectral variability in the optical (see Salamanca et al. 1994) and in X-ray (George et al. 1998). A NICMOS image of Quillen et al. (1999) shows resolved H_2 1-0 S(1) line emission which our data also reveals. The H_2 emission is elongated in the same way as the compact ^{12}CO (1-0) millimeter interferometric map of Schinnerer, Eckart, & Tacconi (2000), and our H_2 peak and the CO peaks (^{12}CO (1-0) and ^{12}CO (2-1)) are offset from the nuclear position, though the H_2 offset is only $\sim 0\farcs3$, smaller than that observed in the interferometric CO observations. Speckle images obtained by Weinberger, Neugebauer, & Matthews (1998) in the H- and K-band show an unresolved point source at or near the diffraction limit of the Palomar 200-inch telescope on top of an extended region of continuum emission (in agreement with our broadband images) and also find that the colors of the nucleus are consistent with hot dust emission, as also suggested by the spectra shown in Figure 2.

5.18. NGC 3393

Diaz, Prieto, & Wamsteker (1988) studied the optical and UV spectra of the nuclear region of NGC 3393 and find no evidence for internal reddening. Further, they find that the spectral type of the dominant stellar population is sufficiently old that it does not contribute to the UV continuum, but rather contributes $\geq$90% of the optical continuum. Their analysis of the IRAS fluxes shows that it can be fit with a combination of two relatively cool components, one at 130 K and the other at 30 K. For comparison, our K-band spectrum shows no clear evidence for hot dust emission (see also Alonso-Herrero et al. 1998). Ferguson et al. (1997), and later Cooke et al. (2000), show optical line strengths and ratios which clearly distinguish this galaxy as a Seyfert 2. The weak 20-100 keV emission seen with *BeppoSAX* has been modelled by Maiolino et al. (1998a) who favor a

cold reflection dominated (Compton thick) model.

5.19. NGC 3783

NGC 3783 is a nearly face-on spiral galaxy hosting a very bright (e.g. Alloin et al. 1995, and references therein) Seyfert 1 nucleus (note the very broad Brγ emission in our K-band spectra). Alloin et al. (1995) find that if the $\alpha = 1$ power law that fits the 0.1 MeV – 0.1 keV emission is extended to longer wavelengths, the resulting IR excess is explainable by a $\sim$60 $M_\odot$ mass of dust with temperatures in the range 200–1500 K. Our K-band spectrum also shows evidence for substantial hot dust emission. H_2 1-0 S(1) line emission from the central $3''\!.4 \times 6''\!.8$ has been marginally detected (Kawara, Nishida, & Gregory 1989), consistent with our upper limit.

5.20. NGC 4051

NGC 4051 has ben referred to as the least luminous “classical” Seyfert 1 (Ho et al. 1997; Weedman 1976). HST archive [OIII] emission line imaging (Schmitt & Kinney 1996) reveals an unresolved nuclear source with fainter extended ($1''\!.2$) emission along a position angle of 100°, similar to the radio continuum structure observed by Ulvestad & Wilson (1984a). Veilleux (1991), in his study of the structure and kinematics of the Narrow Line Regions in Seyfert galaxies, notes that the line profiles of *all of the observed forbidden lines* show pronounced blue wings. There are no corresponding red wings, which led him to propose a model including outflow towards us plus dust obscuration to extinct the flow away from us. Hot dust has also been invoked to explain the mid- and far-infrared continuum emission (Rodríguez Espinosa et al. 1996; Contini & Viegas 1999); the former authors differentiate between hot dust heated by the AGN and somewhat cooler dust which is heated by star formation. Variability of NGC 4051 occurs on a number of different timescales. Salvati et al. (1993) report an outburst at 2.2 μm of more than a factor of 2 in 6 months in 1992, over which time the UV emission appears to be less variable. X-ray variability with timescales as short as a few hundred seconds has been observed by *EXOSAT* (Lawrence et al. 1985), while Done et al. (1990) report on observations of strong X-ray variations within timescales of tens of minutes. Finally, Singh (1999) present a high resolution X-ray map for the nuclear region ($5''$–$10''$) of NGC 4051 and interpret it as due to central (nuclear) activity plus an extended starburst component.

5.21. NGC 4258 (=M 106)

NGC 4258 contains a nuclear thin disk in Keplerian rotation, traced by emission from water masers (Miyoshi et al. 1995). The implied enclosed mass density, 3.6×10^7 $M_\odot$ within 0.14 pc of the nucleus (Herrnstein et al. 1996), consistent with a supermassive central black hole. In spite of the clear presence of a nuclear black hole, NGC 4258 is a relatively inactive system. Both the nuclear Hα and radio continuum luminosities are low, and the nucleus was originally undetected in X-ray observations made with the *Einstein Observatory* (Ford et al. 1986, and references therein). Subsequent observations with *ASCA* have revealed a low luminosity obscured active nucleus (Makishima et al. 1994), and Filippenko & Sargent (1985) have observed very weak broad Hα emission. Our K-band image (see Figure 3) shows an unresolved central source, and recently Chary et al. (2000) have shown this source to be unresolved down to $0\farcs2$ FWHM resolution. These authors have also fit their NIR flux densities with a single, non-thermal, powerlaw ($\nu^{-1.4\pm0.1}$), using a foreground screen extinction correction corresponding to an A_V of 18 magnitudes.

5.22. NGC 4639

This galaxy contains many HII regions which lie both at the ends of a stellar bar and in a ring $30''$ from the nucleus (González-Delgado et al. 1997). The AGN itself appears to contribute very little (3%) to the total ionizing luminosity (González-Delgado et al. 1997). Owing to their detection of broad hydrogen emission lines (FWHM = 3600 km s^{-1} for Hα), Ho et al. (1997) classified this galaxy as Seyfert 1 (although low-luminosity). Further, they report an Hα flux variation of $\sim$10% between two observations a year apart, though caution should be used in interpretting this due to the sensitivity of the result on detailed stellar light removal. The Seyfert nucleus, which is pointlike in the *ROSAT* soft X-ray band, has a low X-ray luminosity but its X-ray spectral properties are very similar to more powerful Seyfert nuclei (Koratkar et al. 1995). Ho et al. (1999), compared *ASCA* data with archival *Einstein* and *ROSAT* data an find variations on scales of months to years, with some suggestion of variability on timescales of $\sim 10^4$ seconds from the *ASCA* data alone.

5.23. Mrk 231

This galaxy is one of the most luminous objects in the local universe (Sanders et al. 1988) – it is a member of the ultraluminous infrared galaxy class of objects, with $L_{IR} \sim 3.5 \times 10^{12}\, L_\odot$ (Lípari, Colina, & Macchetto 1994). The presence of an AGN is revealed by many observations. In the radio, Preuss & Fosbury (1983), Neff & Ulvestad (1988), and Ulvestad, Wrobel, & Carilli (1999) have reported on the existence of a

very compact, variable, self-absorbed source in the nucleus. That, in combination with the observed parsec-scale jet (Neff & Ulvestad 1988; Ulvestad, Wrobel, & Carilli 1999; Taylor et al. 1999), clearly signals the presence of an AGN. Moreover, UV and optical polarization observations (Goodrich & Miller 1994; Smith et al. 1995) point towards the existence of a central, highly polarized, nonthermal source. Its X-ray emission is weak compared to normal Seyfert 1 galaxies and although hard X-ray emission is detected, no variation is observed (Nakagawa et al. 1999; Turner 1999). Our K-band imaging spectroscopy reveals the presence of an unresolved central source. Weinberger, Neugebauer, & Matthews (1998) have used speckle techniques at 1.6 and $2.2\,\mu$ to demonstrate that this nuclear source is unresolved down to roughly the diffraction limit of the Palomar 200-inch telescope. Mrk 231 is also host to several blueshifted broad absorption line systems seen in UV data (see references in Turner 1999), the shapes and velocities of which are similar to those seen in BAL QSOs (Rudy, Foltz, & Stocke 1985). Strong (circumnuclear) starformation is also indicated by a number of observations. The VLBA and VLA observations of Taylor et al. (1999) show, in addition to the nuclear jet, an extended component of size 100–1000 pc, which they associate with a region of starformation. They also report the presence of 4 yet-to-be-confirmed radio supernovae. Regions of active circumnuclear star formation have been seen in the optical observations of Hutchings & Neff (1987) and Hamilton & Keel (1987). Groundbased J-, H-, and K-band observations with arcsecond seeing revealed the presence of a second source 3.5 arcseconds south of the nucleus (Armus et al. 1994). This source was originally described as a second nucleus, but higher resolution *HST*/WFPC2 observations of Surace et al. (1998) have shown that to be a string of starforming knots. Millimeter interferometric observations CO in Mrk 231 reveal the presence of a dense, rotating, compact, nuclear disk of molecular gas (Downes & Solomon 1998), which the authors argue fuels a circumnuclear starburst. Further, Ulvestad, Wrobel, & Carilli (1999) note that the $L_{\rm X}/L_{IR}$ ratio implied by the *ASCA* observations (Nakagawa et al. 1999) is more consistent with that seen in starburst galaxies than for AGN. Krabbe et al. (1997) present non-ROGUE-assisted K-band 3D integral field spectroscopy and find extended circumnuclear emission from thermally excited hot molecular gas as traced by the H_2 lines. Although present, the CO-bandhead stellar absorption feature at $2.29\,\mu$m appears to be sitting on the steep slope of a rising hot dust continuum. The results presented here, although of poorer signal-to-noise, are consistent with these findings.

5.24. NGC 4945

There is a debate in the literature whether NGC 4945, one of the brightest infrared galaxies in the sky ($L_{8-1000\,\mu m} = 2.95 \times 10^{10}\,{\rm L}_{\odot}$, Spoon et al. (2000), and references therein), harbors an AGN. The side taken is a strong function of wavelength observed. Firm evidence for the presence of an AGN comes primarily from (hard) X-ray obser-

vations. Iwasawa et al. (1993) report the results of *Ginga* observations in which the 2–10 keV band has a powerlaw emission spectrum with photon index ∼1.7, an absorption-corrected luminosity of 3×10^{42} ergs s^{-1}, and strong variability on a timescale of several hours. Similar results based on *BeppoSAX* observations are presented by Guainazzi et al. (2000). Done, Madejski, & Smith (1996) use OSSE data to determine that NGC 4945 is the second brightest Seyfert at hard X-ray energies (the brightest being NGC 4151). Those authors aptly note that the AGN in NGC 4945 sits behind an obscuring column of $\sim 5 \times 10^{24}$ cm^{-2} (Iwasawa et al. 1993), rendering it invisible at all energies below 10 keV (see also Spoon et al. 2000). Spectroscopy at mid-IR wavelengths with *ISO* (Spoon et al. 2000) suggest that at least 50% of the bolometric luminosity of NGC 4945 derives from massive star-formation, which is heavily obscured by 36^{+18}_{-11} magnitudes of visual extinction. Spoon et al. (2000) see no evidence from the mid-IR lines for excitation attributable to an AGN. The starburst in this galaxy has produced a superwind which has evacuated a cone-shaped structure, perpendicular to the plane of the galaxy (Heckman, Armus, & Miley 1990; Lehnert & Heckman 1996; Moorwood et al. 1996b). Quillen et al. (1999) and Marconi et al. (2000) both present *HST* NICMOS imaging spectroscopy of the 1-0 S(1) line of H_2 at 2.12 μm. The H_2 emission is extended, and traces the inside edges of the superwind bubble (Marconi et al. 2000). Our H_2 line map also shows extended emission which agrees well with the bright central emission seen by Marconi et al. (2000), though our field of view is insufficient to trace out the full extent of the superwind cavity. Our H_2 flux within a 4″ aperture is consistent with 1.1×10^{-13} ergs cm^{-2} s^{-1} observed within a 6″ × 6″ nuclear aperture by Marconi et al. (2000). Our [FeII] map shows extended bubble-like emission similar to, but smaller in scale than, that found by Marconi et al. (2000).

5.25. Mrk 273 (=UGC 8696)

Mrk 273 is an ultraluminous infrared galaxy (log $L_{IR} = 12.11\ L_\odot$). That an AGN at least contributes to the excitation of the nuclear region is indicated by the optical spectroscopy of Koski (1978); Sanders et al. (1988) (see also the K-band spectrum of Veilleux, Sanders, & Kim (1999)), as well the strong high excitation lines observed by *ISO* (Genzel et al. 1998). The latter work, however, also shows Mrk 273 to have a relatively strong 7.7 μm PAH feature, suggesting that of order 50% of the nuclear gas excitation is due to a starburst. The starburst nature of the nucleus is also demonstrated by the K-band spectrum presented by Goldader et al. (1995), though this spectrum does extend beyond the red nuclear region to the bluer disk (Scoville et al. 2000). In contrast, our K-band spectra extracted over the central 4″ are much redder with apparently weaker stellar features, and are consistent with the spectrum of Veilleux, Sanders, & Kim (1999) over a similar region. The *ASCA* observations of Mrk 273 indicate that it contains a Seyfert nucleus of at least moderate luminosity (Iwasawa 1999). Observations of the nuclear

region at higher spatial resolution than those discussed above have recently been made in the NIR[3] (Knapen et al. 1997; Scoville et al. 2000) and in the radio by Knapen et al. (1997) and Carilli & Taylor (2000). These measurements collectively show the "nucleus" to be composed of three separate sources, denoted N, SE, SW. Of the two bright NIR sources, N, and SW, only N is detected in the radio. Knapen et al. (1997), Scoville et al. (2000), and Carilli & Taylor (2000) all discuss the nature of the three sources, and come to somewhat conflicting viewpoints. Knapen et al. (1997) argue in favor of the northern source being an AGN, while Scoville et al. (2000) and Carilli & Taylor (2000) present compelling arguments for that component to be starburst in nature. Further, Carilli & Taylor (2000) interpret their HI absorption line data from the northern nucleus as indicative of a gaseous disk in rotation, with the inferred enclosed mass ($2 \times 10^9\,M_\odot$) being fully consistent with the molecular gas observed by Downes & Solomon (1998). Scoville et al. (2000) posit that the AGN is the SW nucleus, which is very red and unresolved in their NICMOS image, while Carilli & Taylor (2000) do not strongly favor either the SE or SW component being an AGN.

5.26. Mrk 463 (=UGC 8850)

Mrk 463 consists of two nuclei, Mrk 463W and E, separated by about $4''$ (Adams 1977, see also our K-band image). Without distinguishing between the two nuclei, Lutz, Veilleux, & Genzel (1999) use newly developed mid-infrared tools to classify Mrk 463 as an AGN. Indeed, Mrk 463E is classified by most authors as a Seyfert 2 (e.g. Schuder & Osterbrock 1981; Hutchings & Neff 1989), and shows in *HST* direct imaging what was initially described as a $0.84''$ long optical jet directed towards the south of the nucleus (Uomoto et al. 1993). The Seyfert 2 nucleus appears as a Seyfert 1 in reflected polarized light (Miller & Goodrich 1990), and more recent *HST* imaging polarimetry has revealed that the "optical jet" is in fact a cone of polarized light extending *northward* from the Seyfert 1 nucleus (Tremonti et al. 1996). In addition, the eastern component is seen to have broad Pa α emission (Veilleux, Sanders, & Kim 1999, consistent with our data which includes only the red side of the line). Mrk 463W, on the otherhand, is classified as either a Seyfert 2 (Schuder & Osterbrock 1981; Mazzarella et al. 1991) or as a LINER (Blanco 1991). Although there are arguments in favor of other classifications, we adopt the Seyfert 2 classification for both nuclei. The unresolved nuclei seen in our K-band data have been shown to be unresolved at higher spatial resolution (Mazzarella et al. 1991).

[3]Knapen et al. (1997) fail to detect the SE nuclear source seen in the *HST* NICMOS image at $0.22''$ resolution (Scoville et al. 2000). This is likely due to a relatively low Strehl ratio, resulting in little power being in the diffraction-limited core of their point spread function. The true resolution of these data is likely not substantially better than their quoted seeing value of $0.6''$. This would also account for the fact that in their image the brighter nucleus is the northern one, rather than the southwestern as seen by Scoville et al. (2000).

5.27. Circinus

Circinus lies close to the galactic plane, within a window of relatively low ($A_V \approx 1.5$ mag.) interstellar extinction (Freeman et al. 1977). It displays several characteristics of a typical Seyfert 2 nucleus: the observed optical line ratio (Oliva et al. 1994), an ionization cone observed in [OIII]λ5007 (Marconi et al. 1995) with the corresponding counter-cone appearing in the 1.97 μm [SiVI] line (Maiolino et al. 2000), narrow prominent coronal lines in its optical/near-IR spectrum (Oliva et al. 1994; Moorwood et al. 1996a; Maiolino et al. 1998b), and broad (FWHM$\approx$ 3300 km s^{-1}) Hα emission detected in polarized light (Oliva et al. 1998). Additional indicators of the presense of an AGN include the existence of a non-stellar source at 2.2 μm whose diameter is less than 3 pc (Maiolino et al. 1998b, though these authors see no compelling evidence for a nuclear black hole), H_2O maser activity (Gardner & Whiteoak 1982; Greenhill et al. 1997), Fe-K fluorescent line emission detected in its X-ray spectrum (Matt et al. 1996), and observed high excitation lines of Ne, S, Mg, O, and Si in the 2.5–45 μm wavelength range (Moorwood et al. 1996a, but see also Binette et al. 1997 and Oliva, Marconi, & Moorwood 1999). Recent star formation in the nuclear region has been detected through the near-IR observations of Maiolino et al. (1998b), who find that the luminosity due to starformation within the central few hundred parsecs is comparable to the AGN luminosity, though the central 14pc (converted to our adopted distance) is dominated by the AGN luminosity, with starformation contributing only 2% of the light. Additional evidence for a nuclear starburst is also provided by the morphology of extended Hα emission, produced as a result of a nuclear "superwind" (Lehnert & Heckman 1996, see also Elmouttie et al. 1998a).

5.28. NGC 5728

This galaxy is a classic example of a Seyfert 2 with biconical emission line cones (Schommer et al. 1988; Wilson et al. 1993; Capetti et al. 1996a), separated by a dark band (Wilson et al. 1993). These ionization cones are essentially colinear, with the position angle of the NW cone axis being 304° and that of the brighter SE cone being 118°. The radio continuum maps at 6 and 20 cm of the nuclear region of NGC 5728 show extensions of similar length and at essentially the same position angles, though the NW extension is the brighter of the two (Wilson et al. 1993). HST imaging polarimetry of the central regions of NGC 5728 has been used to determine the position of the nucleus which lies behind the dark band (Capetti et al. 1996a). These authors place the nucleus at a point defined by the apexes of the two ionization cones, in agreement with Wilson et al. (1993). Apart from the cones, the nuclear region of NGC 5728 shows other interesting features. In the red and green optical continuum images presented by Wilson et al. (1993), there exist two miniature bars delineated by four main knots of emission (A–D) and aligned EW (that is, colinear with neither the cones or the larger scale stellar bar). We note in this context that our K-band image is consistent with this innermost bar feature, seen at

poorer spatial resolution.

5.29. NGC 7469

NGC 7469 is often cited as the prototypical Seyfert 1 galaxy. A variety of observations at high spatial resolution indicate that the active nucleus is surrounded by a more or less complete ring of starburst activity (Mauder et al. 1994; Genzel et al. 1995; Miles, Houck, & Hayward 1994; Wilson et al. 1991). Genzel et al. (1995) have modelled their high resolution NIR imaging and imaging spectroscopic data[4] and find that two thirds of the bolometric luminosity of the entire galaxy originates in this starburst ring. Pérez-Olea & Colina (1996) cannot spatially resolve the starburst ring in their *ROSAT* HRI data but derive its X-ray luminosity by using the results of the radio observations of Wilson et al. (1991) together with the assumption that its $L_{\rm X}/L_{5\,{\rm GHz}}$ ratio is typical of starbursts ($\sim$400). They then arrive at the conclusion that only 4% of the total X-ray luminosity is produced in the ring. The active nucleus itself is seen to vary in the X-rays over timescales from hours (Barr 1986) to days (Leighly et al. 1996). Doroshenko, Lyutyi, & Rakhimov (1989) report on nuclear optical variations with timescales ranging from hours to years. In the infrared, Glass (1998) found small ($<$0.3 mag) variations during the course of 13 years of observations, except for a substantial dimming in 1989 during which the nuclear flux dropped to one fifth its normal value. Related decreases in the U and B brightnesses, along with the disappearance of the broadline component of Hβ are reported by Glass (1998, and references therein).

5.30. Mrk 315 (=II Zw 187)

Mrk 315, which has been classified as a Seyfert 1.5 (Koski 1978), has a "jet-like" structure which extends straight at position angle 324° for 45 h^{-1} kpc before curving back towards the southeast (MacKenty 1986; MacKenty et al. 1994). The origin for this feature, which is seen only in [OIII] and Hα (but see also Nonino et al. 1998), is likely due to a tidal interaction. A knot is seen at optical, near-infrared, and radio wavelengths which lies 2″ to the east of the nucleus (MacKenty 1986; MacKenty et al. 1994; Nonino et al. 1998, see also our K-band image). The nature of this knot is not certain, with MacKenty et al. (1994) describing it as a recently captured galaxy remnant and Nonino et al. (1998) attributing it to an intense starburst region. An extended region of radio continuum emission asymmetrically envelopes the nucleus and this secondary

[4]The NIR imaging spectroscopic observations of NGC 7469 reported on by Genzel et al. (1995) were made with MPE's NIR imaging Fabry-Perot FAST as well as 3D. The 3D observations were made during the 3D commissioning run and did not benefit from tip-tilt guiding. 3D observations reported on in this work were made on a subsequent run with tip-tilt correction.

knot (Ulvestad, Wilson, & Sramek 1981; Ulvestad & Wilson 1984a; Nonino et al. 1998) and is consistent with a starburst origin (Wilson 1988). Within this radio continuum region lies two complex arms or arcs of emission. The brighter of the two appears to connect the nucleus and the secondary peak, and then arc northward of the nucleus (especially well shown in Figure 4 of Nonino et al. 1998). The second arc lies to the west of the nucleus and is blue in color, appearing in J- and H-band images but not at K-band Nonino et al. (1998). These arcs are likely due to the recent tidal interaction used to explain the secondary peak (MacKenty et al. 1994).

5.31. NGC 7582

NGC 7582 presents a fascinating puzzle. It is a classical Seyfert 2 galaxy, with a well-defined [OIII] cone (Morris et al. 1995; Storchi-Bergmann & Bonatto 1991) and normally narrow emission lines (e.g. Cid Fernandes, Storchi-Bergmann, & Schmitt 1998). Its lack of broad lines in spectropolarimetric observations coupled with a high 60 μm/25 μm flux ratio led Heisler, Lumsden, & Bailey (1997) to infer that the nucleus itself is totally obscured, even to scattered light, by an edge-on thick torus surrounding it. This is also consistent with the results of *Ginga* observations of NGC 7582 (Warwick et al. 1993). That stars contribute to the nuclear luminosity of NGC 7582 has been demonstrated by the work of Oliva et al. (1995). They find, through observations of strong CO bandhead absorption lines and an inferred large near-IR light-to-mass ratio that young supergiants are present and dominate the H- and K-band nuclear luminosity (but see also Schmitt, Storchi-Bergmann, & Cid Fernandes 1999, who find, based on spectral synthesis fitting to optical spectra, that only 6% of the optical light is due to young stars). There is also a kiloparsec-scale disk of HII regions surrounding the nucleus (Morris et al. 1995).

Recently, Aretxaga et al. (1999) report on the detection of hitherto unseen broad lines in the optical spectra, effectively for a few months turning this classical Seyfert 2 galaxy into a Seyfert 1 galaxy. These authors debate the pros and cons of three models to explain the sudden appearance of the broad lines: the capture of a star by a nuclear black hole, a reddening change in the surrounding obscuring torus, and the radiative onset of a Type IIn supernova. The first two of these models deal directly with the active nucleus and its obscuring surroundings, while the last model invokes pure stellar processes. Aretxaga et al. (1999) raise serious concerns with the first two models, and favor the SN theory. Evidence in favor of a nuclear-based explanation comes from the *BeppoSAX* observations of Turner et al. (2000). They observed NGC 7582 in 1998 November and found a previously unseen hard X-ray component. Correlated variability across the X-ray spectrum led Turner et al. (2000) to the conclusion that a single component dominates the 2–100 keV band. Further, these variations do not seem to be at all correlated with those in the optical reported on by Aretxaga et al. (1999).

NGC 7582 was observed twice in the K-band, once before and once just after the optical anomaly. The second set of observations were done after the anomaly was brought to our attention (R. Terlevich, private communication). A more detailed analysis of our observations will be presented in a subsequent paper, but here we note simply that our second observations show a broadening of the Brγ line, along with a reddening of the continuum in the seeing weighted aperture. Our observed Brγ equivalent width for the 1994 July ESO 2.2m observations agrees well with that obtained by Oliva et al. (1995) who also observed NGC 7582 during its "quiescence."

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Fig. 1.— Most relevant diagnostic diagram used for spectral classification. Dots show the location of the sources in this paper. The Baldwin, Phillips, & Terlevich (1981) model for HII regions is over-plotted, as well as the limits [OIII]λ5007/Hβ = 3 and [NII]λ6583/Hα = 0.5. Three different regions are delineated, the Seyfert region on the upper right, the LINERs on the lower right and the HII around the plotted model (about the dashed region).

Fig. 2.— H- and K-band spectra of the galaxies in the sample. Wavelengths are in the observed frame. The top spectrum in each panel is the seeing-weighted (nuclear) spectrum (see text for details). The middle spectrum in each panel shows a spectrum extracted over a $3''$ or $4''$ (as indicated in the upper right-hand corner of each plot) uniformally weighted aperture, while the bottom spectrum of each panel (labeled as 'sub') shows the difference between the middle and top spectra. In the bottom box for each panel, prominent stellar absorption lines (even if not detected) and all of the significantly detected emission lines are marked. The $\oplus$ symbol indicates telluric features.

Fig. 3.— Images from the 3-dimensional data cube of all the galaxies in the sample. The object names and bands over which the images were generated are indicated in the label above each plot and the axes show the offset relative to the broad band peak for each galaxy in each image. In each map the contours start at 90% of the peak surface brightness listed in Tables 6–8, and continue as 80%, 70%, ..., 10%, 5%. In all images, north is at the top, east is to the left.

Table 1. Observed Galaxy Sample and Adopted Distances

Galaxy (1)	RA (2)	Dec (3)	Ref. (4)	Galaxy Type (5)	V_{3K} (6)	Distance (Mpc) (7)	Note (8)
Mrk 348	00 48 47.1	+31 57 25	1	SA(s)0/a:	4411	59	a
I Zw 1	00 53 34.9	+12 41 36	2	S?	17870	238	a
Mrk 573	01 43 57.8	+02 21 00	2	(R)SAB(rs)0^+:	4871	65	a
Mrk 1044	02 30 05.4	−08 59 53	3	S?	4660	62	a
NGC 1068	02 42 40.7	−00 00 48	4	(R)SA(rs)b	871	14.4	b
NGC 1097	02 46 19.1	−30 16 28	5	SB(s)b	1110	14.5	b
NGC 1194	03 03 49.2	−01 06 13	6	SA0^+:	3764	50	a
NGC 1275	03 19 48.1	+41 30 42	7	Pec	5100	68	a
NGC 1365	03 33 36.4	−36 08 25	8	SB(s)b	1579	18.6	c
NGC 1386	03 36 45.4	−35 59 57	9	SB(s)0^+	772	18.6	d
NGC 1433	03 42 01.4	−47 13 20	10	(R')SB(r)ab	911	11.6	b
NGC 1566	04 20 00.6	−54 56 17	9	SAB(s)bc	1440	13.4	b
NGC 1672	04 45 42.1	−59 14 57	11	SB(s)b	1300	14.5	b
Mrk 1095	05 16 11.4	−00 08 59	2	S?	9936	132	a
NGC 2110	05 52 11.4	−07 27 22	12	SAB0^-	2353	31	a
NGC 3079	10 01 57.8	+55 40 47	13	SB(s)c sp	1260	20.4	b
NGC 3227	10 23 30.6	+19 51 54	2	SAB(s)a pec	1466	20.6	b
NGC 3393	10 48 23.4	−25 09 43	14	(R')SB(rs)a:	4079	54	a
NGC 3783	11 39 01.8	−37 44 19	9	(R')SB(r)ab	3242	43	a
NGC 4051	12 03 09.6	+44 31 53	2	SAB(rs)bc	910	17.0	b
NGC 4258	12 18 57.5	+47 18 14	15	SAB(s)bc	684	7.3	e
NGC 4639	12 42 52.4	+13 15 27	16	SAB(rs)bc	1216	25.5	f
Mrk 231	12 56 14.2	+56 52 25	17	SA(rs)c pec	12440	166	a
NGC 4945	13 05 27.5	−49 28 06	18	SB(s)cd sp	826	3.7	g
Mrk 273	13 44 42.1	+55 53 13	12	Pec	11400	152	a
Mrk 463W	13 56 02.6	+18 22 18	9	S?	15537	205	a
Mrk 463E	13 56 02.9	+18 22 19	2	S?	15388	205	a
Circinus	14 13 09.3	−65 20 21	19	SA(s)b:	530	4.2	h
NGC 5728	14 42 23.9	−17 15 11	9	SAB(r)a:	3111	41	a
NGC 7469	23 03 15.6	+08 52 26	2	(R')SAB(rs)a	4477	60	a
Mrk 315	23 04 02.6	+22 37 28	2	E1 pec	11280	150	a
NGC 7582	23 18 23.5	−42 22 14	20	(R')SB(s)ab	1325	17.6	b

Note. — Col. (1) — Source designation. Col. (2) and (3) — Right Ascension and declination (J2000). Col. (4) — Reference for the coordinates listed in Col. (2) and (3). 1) Wilkinson et al. (1998), 2) Clements (1981), 3) Argyle & Eldridge (1990), 4) Capetti, Macchetto, & Lattanzi (1997), 5) Coziol et al. (1994), 6) Falco et al. (1999), 7) Johnston et al. (1995), 8) Lindblad et al. (1996), 9) Veron-Cetty & Veron (1996), 10) Maoz et al. (1996), 11) Lauberts (1982), 12) Clements (1983), 13) Baan & Irwin (1995), 14) Faúndez-Abans & de Oliviera-Abans (1998), 15) Turner & Ho (1994), 16) The 2MASS Team (1999), 17) Ma et al. (1998), 18) Greenhill, Moran, & Herrnstein (1997), 19) Fairall, Woudt, & Kraan-Korteweg (1998), 20) Joguet, Kunth, & Terlevich (1998) Col. (5) — Galaxy classification of the host as given by de Vaucouleurs et al. (1991). Note that de Vaucouleurs et al. (1991) make no distinction between Mkn 463W and Mkn 463E. Col. (6) — Optical systemic velocity, V_{obs}, (in km s^{-1}) from de Vaucouleurs et al. (1991) (except for NGC 1194 [taken from de Grijp et al. (1992)], Mkn 463W [taken from Veron-Cetty & Veron (1996)], and Mkn 463E [taken from Hewitt & Burbidge (1991)), corrected to the microwave background frame, using Eq. (1). Col. (7) — Distance to the source, in Mpc. Col. (8) — The source for the adopted distance: a) D = V_{3K}/H_0, where H_0 is taken to be 75 km sec^{-1} Mpc^{-1}, b) taken from Tully (1988) which corrects for Virgocentric infall of 300 km sec^{-1}, c) HST observations of Cepheid variables (Madore et al. 1999), d) same value as NGC 1365 (see Note c) as they are in the same group, e) water maser measurements (Herrnstein et al. 1997), f) HST observations of Cepheid variables (Saha et al. 1997), g) value based on the mean distance modulus to NGC 5128 (Ferrarese et al. 2000), since NGC 4945 is in the same group, h) average value from Freeman et al. (1977), corrected to our adopted H_0 value.

Table 2. Summary of Optical Emission Ratios and Seyfert Class

Galaxy (1)	[OIII]/Hβ (2)	[NII]/Hα (3)	[SII]/Hα (4)	[OII]/[OIII] (5)	[OI]/Hα (6)	[OI]/[OIII] (7)	Class (8)	Refs (9)
Mrk 348	11.74	0.83	0.85	0.38	0.39	0.091	S2	1
I Zw 1	0.82	···	···	0.48	···	···	NLS1/HII	2
Mrk 573	12.3	0.84	0.53	0.19	0.10	0.026	S2	3
Mrk 1044	1.67	···	0.06	···	0.008	0.015	NLS1	4
NGC 1068	13.14	0.82	0.09	0.035	0.10	0.031	S2	5
NGC 1097	5.1	3	0.7	0.78	···	···	S1.5	6
NGC 1194	>8.42	0.29	···	···	···	···	S1.5	7
NGC 1275	3.63	0.42	0.3	0.99	0.71	0.42	S1.5/L	8
NGC 1365	3	0.55	0.34	0.92	···	···	S1.5/HII	9,10
NGC 1386	12.2	1.276	0.56	0.178	0.13	0.032	S2	11
NGC 1433	2	1.54	0.98	1.15	···	···	L	9,12
NGC 1566	6.5	0.35	0.18	1.04	···	···	S1	13
NGC 1672	2.1	1.41	0.4	0.62	···	···	L	6
Mrk 1095	5.6	0.8	0.48	···	<0.28	<0.12	S1	4
NGC 2110	4.76	1.41	1.11	0.92	0.45	0.25	S2	2,14
NGC 3079	4.15	1.59	0.86	···	0.18	0.13	S2	15
NGC 3227	5.91	1.33	0.68	0.177	0.23	0.12	S1.5	15,16
NGC 3393	10.2	1.2	···	0.22	0.12	0.034	S2	17,18
NGC 3783	5.5	0.18	0.14	0.076	0.081	0.043	S1	19
NGC 4051	4.5	0.64	0.36	0.292	0.14	0.093	S1	15,16
NGC 4258	10.32	0.80	0.94	···	0.38	0.11	S1.5	15
NGC 4639	3.77	1.12	1.09	···	0.31	0.25	S1	15
Mrk 231	···	···	···	···	···	···	S1	20
NGC 4945	···	1.3	0.9	···	···	···	HII/S2/L	21
Mrk 273	3.63	0.87	0.50	2.21	0.081	0.063	S2/L	24
Mrk 463W	3.0	0.57	0.62	···	···	···	S2	23
Mrk 463E	8.5	0.45	0.39	···	0.14	0.040	S2	23
Circinus	10.25	1.15	0.64	0.26	0.14	0.41	S2	25
NGC 5728	11.8	1.40	0.33	0.32	0.17	0.085	S2	2,22
NGC 7469	6.07	0.59	0.28	0.40	0.077	0.079	S1	19
Mrk 315	2.56	0.51	0.22	0.86	0.049	0.062	S1.5/HII	1
NGC 7582	2.33	0.69	0.274	0.482	0.027	0.042	S2/HII	19

Note. — Col. (1) — Source designation. Col. (2) through (7) — Nuclear line ratios of our Seyfert sample. All but I Zw 1, Mrk 1044, NGC 1194, NGC 4945, and NGC 7469 were corrected for extinction. An underlying absorption-correction was made for all sources except I Zw 1, Mrk 1044, NGC 1068, and Mrk 1095. For NGC 1365 the listed [NII]/Hα and [SII]/Hα ratios correspond to a position 2″ to the south of the nucleus. Col. (8) — AGN classification (see text for details). Col. (9) — References for emission line properties: 1) Koski (1978), 2) Cruz-González et al. (1994), 3) Storchi-Bergmann et al. (1996c), 4) Rafanelli & Schulz (1991), 5) Kraemer, Ruiz, & Crenshaw (1998), 6) Storchi-Bergmann, Wilson, & Baldwin (1996a), 7) de Grijp et al. (1992), 8) Ho, Filippenko, & Sargent (1993), 9) Alloin & Kunth (1979), 10) Schulz et al. (1999), 11) Storchi-Bergmann et al. (1996b), 12) Storchi-Bergmann, Kinney, & Challis (1995), 13) Fricke & Kollatschny (1989), 14) Shuder (1980), 15) Ho, Filippenko, & Sargent (1997), 16) Schmitt (1998), 17) Ferguson et al. (1997), 18) Cooke et al. (2000), 19) Bonatto, Bica, & Alloin (1989), 20) Sanders et al. (1988), 21) Lípari, Tsvetanov, & Macchetto (1997), 22) Phillips, Charles, & Baldwin (1983), 23) Chatzichristou & Vanderriest (1995), 24) Liu & Kennicutt (1995), 25) Oliva, Marconi, & Moorwood (1999). See text for details on Mrk 231 and NGC 4945.

Table 3. Definition of Observed Bands

Band (1)	Bandwidth (2)	R (3)
H	1.48–1.78	1250
HH	1.55–1.75	2100
K	1.94–2.41	1100
KL	2.17–2.43	2100

Note. — Col. (1) — Band designation. Col. (2) — Wavelength coverage in microns. Col. (3) — Resolution, $R = \Delta\lambda/\lambda$

Table 4. Observing Runs

Observatory (1)	Telescope (2)	pixel size (3)	FOV ($''$) (4)	Dates of Runs (5)
Calar Alto	3.5m	0.3, 0.5	4.8, 8.0	Nov/Dec 1993, Jan 1995, Jul/Aug 1997, Jul 1998
La Palma	WHT/4.2m	0.3, 0.5	4.8, 8.0	Apr 1994, Dec 1995/Jan 1996
ESO	2.2m	0.3, 0.5	4.8, 8.0	Jul/Aug 1994, Mar 1996, Apr 1996
Siding Springs	AAT/3.9m	0.25, 0.4	4.0, 6.4	Nov 1997, Dec 1997, Feb 1998, Mar 1998
				Oct 1998, Nov/Dec 1998, Feb 1999, Apr 1999

Table 5. Summary of Data Obtained and Literature Photometry

Galaxy (1)	Int (2)	Obs (3)	Date (4)	Band (5)	seeing (6)	Pixel Scale (7)	K (8)	H (9)	Aperture (10)
Mrk 348	1200	3.5m	8/97	K	1.0	0.5	12.17	12.72	3
I Zw 1	4200	3.5m	1/95	K	1.0	0.5	9.90	11.00	8.5
	2370	WHT	12/95	H	1.0–1.5	0.5	...	...	...
Mrk 573	4480	2.2m	8/94	K	1.5	0.5	11.78	12.27	3
Mrk 1044	8760	2.2m	8/94	K	1.5	0.5	...	...	...
	3300	AAT	10/98	HH	1.5	0.4	...	...	...
NGC 1068	5560	WHT	1/96	K	0.7	0.3	7.65	8.53	6
	1800	AAT	11/97	H	1.0	0.4	...	...	...
NGC 1097	1200	AAT	11/97	K	0.9	0.4	9.90	10.22	6
	1800	AAT	11/97	H	0.9	0.4	...	...	...
NGC 1194	2000	AAT	12/98	K	2.0	0.4	...	...	...
NGC 1275	4680	3.5m	1/95	K	1.0–1.5	0.5	11.86	12.82	3
	1920	3.5m	1/95	H	1.3	0.5	...	...	...
NGC 1365	3000	AAT	12/97	K	0.7	0.25	9.00	9.73	9.15
	2520	AAT	12/97	H	0.5–1.0	0.4	...	...	...
NGC 1386	2800	AAT	12/97	K	1.0	0.4	10.12	10.45	6
	2400	AAT	12/97	H	0.8	0.4	...	...	...
NGC 1433	2600	AAT	12/97	K	0.9	0.4	9.09	9.35	18
	2760	AAT	12/97	H	0.8–1.6	0.4	...	...	...
NGC 1566	2600	AAT	11/97	K	0.5	0.4	9.85	10.36	6
	2880	AAT	11/97	H	0.8	0.4	...	...	...
NGC 1672	3200	AAT	12/97	K	0.9	0.4	10.73	11.31	3
	1680	AAT	12/97	H	0.5	0.25	...	...	...
Mrk 1095	3360	WHT	12/95	K	1.2	0.5	10.39	11.26	4.6
	2700	WHT	1/96	H	1.2	0.3	...	...	...
NGC 2110	340	WHT	1/96	K	0.5	0.3	10.77	11.41	3
	2655	WHT	1/96	H	1.7	0.5	...	...	...
NGC 3079	1530	3.5m	12/93	K	2.0	0.5	10.49	11.24	3
NGC 3227	4000	WHT	1/96	K	1.0	0.5	9.85	10.35	8.5
	1320	WHT	1/96	H	1.0	0.5	...	...	...
NGC 3393	6400	AAT	3/98	KL	0.8–1.4	0.4	11.51	11.8	3
NGC 3783	1800	AAT	12/97	K	1.5	0.4	9.88	10.82	6
	1440	AAT	12/97	H	1.3	0.4	...	...	...
NGC 4051	3120	WHT	12/95	K	0.9	0.3	10.05	10.86	8.5
	2130	WHT	12/95	H	1.0	0.3	...	...	...
NGC 4258	5200	3.5m	1/95	K	1.0	0.5	9.74	10.03	7.2
NGC 4639	3600	AAT	3/98	KL	1.4	0.4	...	...	...
Mrk 231	3580	WHT	1/96	K	1.0	0.5	8.97	10.37	8.5
NGC 4945	1680	AAT	4/99	K	2.3	0.4	9.32	10.60	6
	1320	AAT	4/99	HH	1.6	0.4	...	...	...
Mrk 273	5000	3.5m	8/97	K	0.9	0.3	11.38	12.14	8.5
Mrk 463‡	1420	WHT	4/94	K	1.5	0.5	10.86E	12.54E	2
	...	...	...	...	...	...	13.77W	14.23W	...
Circinus	8430	2.2m	3/96	K	0.6	0.3	8.53	9.25	5
	12200	2.2m	4/96	KL	0.8	0.3	...	...	...
NGC 5728	8000	2.2m	7/94	K	1.0–1.5	0.5	10.30	10.53	9.1
NGC 7469	6400	3.5m	7/97	K	1.0	0.5	9.92	10.66	3.9
	4040	3.5m	7/97	HH	1.0	0.3	...	...	...
Mrk 315	8000	3.5m	8/97	K	1.0	0.5	11.51	11.95	8.5
NGC 7582	11640	2.2m	7/94	K	1.0–1.5	0.5	9.13	9.98	6
	1600	AAT	10/98	K	1.0	0.4	...	...	...
	3400	AAT	10/98	HH	1.1	0.4	...	...	...

Note. — Col. (1) — Source designation. Col. (2) — Total on source integration time (in seconds) over the bandpass indicated in Col. (5). Col. (3) — Telescope at which the observations were made. See also Table 4. Col. (4) — Date of the observations in the form month/year. Col. (5) — Band used. See Table 3 for details. Col. (6) — Seeing during the observations in arc seconds. If the overall variation in the seeing during the observations was greater than $0.4''$ the range of seeing during the total integration time is provided. Col. (7) — The projected pixel size in arcseconds for our observations. Col. (8) and (9) — K- and H-Band aperture magnitudes from de Vaucouleurs & Longo (1988) for most of the galaxies, but also from Alonso-Herrero et al. (1998) for NGC 1068, NGC 3393, Mrk 348, Mrk 463 and Mrk 573, and from Forbes et al. (1992) for NGC 1275, NGC 1672, NGC 2110 and NGC 3079. Col. (10) — Aperture in arcseconds through which the magnitudes in Cols. (8) and (9) were measured. Apertures chosen were those which most nearly matched our observed field-of-view. When this was not possible, the smallest aperture available is quoted. ‡Observations of Mrk 463W and Mrk 463E (observed simultaneously due to their small separation) were compromised by a H-band leak in the K-band order selecting filter, which was only discovered after the fact (see also Krabbe et al. 1997).

Table 6. K-band Flux and Properties of the Brγ Emission Line

Galaxy (1)	K-band Flux (2)	K-band Peak (3)	Brγ Peak (4)	EW(Brγ) (5)	σ_{EW} (6)	Flux (7)	σ_{Flux} (8)	cz (9)	σ_{cz} (10)	W (11)	σ_W (12)
Mrk 348	0.17	0.24	···	2.0	0.5	0.33	0.09	4370	70	530	110
2	0.37			2.3	0.7	0.83	0.27	4280	110	820	110
4	0.61			<1.5	···	<0.94	···	···	···	···	···
I Zw 1	2.0	3.5	20	8.4	0.4	16	0.8	18050	70	2340	90
2	3.6			7.8	0.4	28	1.6	17980	80	2360	110
4	4.5			7.2	0.5	32	2.4	17970	110	2350	140
Mrk 573	1.1	0.78	···	5.0	0.4	5.6	0.5	5300	25	540	50
2	1.5			4.9	0.6	7.4	0.9	5280	40	510	80
4	3.4			5.2	0.6	18	2.1	5320	30	540	60
Mrk 1044*	0.67	···	···	15	0.9	9.8	0.6	4800	80	2350	140
2	0.92			14	1.2	13	1.1	4730	100	2250	180
4	1.5			19	1.2	28.7	1.8	5010	100	3180	130
NGC 1068†	8.5	24	23	2.3	0.1	19	0.9	990	20	806	40
2	23			2.5	0.1	56	3.0	972	26	775	40
4	30			2.6	0.2	77	4.5	980	30	785	50
NGC 1097	0.35	0.48	···	<0.81	···	<0.29	···	···	···	···	···
2	1.0			<0.77	···	<0.82	···	···	···	···	···
4	2.8			<0.72	···	<2.1	···	···	···	···	···
NGC 1194*	1.1	···	···	<0.71	···	<0.77	···	···	···	···	···
2	0.97			<1.1	···	<1.1	···	···	···	···	···
4	2.4			<0.85	···	<2.0	···	···	···	···	···
NGC 1275	0.30	0.40	4.4	9.8	0.9	3.0	0.3	5080	40	850	70
2	0.48			9.6	0.8	4.6	0.4	5070	30	880	60
4	0.88			8.5	0.7	7.5	0.6	5070	50	990	70
NGC 1365†	1.5	4.3	33	10.3	0.4	16	0.6	670	65	2690	100
2	4.8			9.0	0.4	43	2.0	815	50	2360	100
3	6.2			8.8	0.5	55	2.9	800	70	2360	160
NGC 1386	0.59	0.50	···	1.0	0.2	0.6	0.1	850	70	260	90
2	0.95			1.1	0.3	1.0	0.3	850	60	···	···
4	2.5			<0.72	···	<1.8	···	···	···	···	···
NGC 1433†	0.15	0.15	···	<0.92	···	<0.14	···	···	···	···	···
2	0.28			<0.92	···	<0.26	···	···	···	···	···
4	0.74			<0.73	···	<0.56	···	···	···	···	···
NGC 1566	0.36	1.1	6.1	5.6	0.6	2.0	0.2	1720	70	1690	100
2	1.5			4.7	0.4	7.4	0.7	1630	50	1670	80
4	3.4			4.0	0.7	14	2.5	1710	110	1760	110
NGC 1672	0.39	0.54	···	<0.46	···	<0.18	···	···	···	···	···
2	1.1			<0.37	···	<0.42	···	···	···	···	···
4	2.9			<0.41	···	<1.2	···	···	···	···	···
Mrk 1095	1.1	1.3	17	14	0.7	16	0.8	9910	120	4300	170
2	1.9			14	0.7	27	1.4	9930	110	4260	160
4	2.8			12	0.7	34	1.9	9940	120	4100	160
NGC 2110	0.25	1.1	···	1.2	0.3	0.31	0.07	2405	40	180	50
2	1.4			1.4	0.4	2.0	0.5	2330	50	310	80
4	2.4			<1.2	···	<3.0	···	···	···	···	···
NGC 3079	1.6	0.65	···	<1.8	···	<2.9	···	···	···	···	···
2	1.4			<2.5	···	<3.7	···	···	···	···	···
4	3.3			<2.0	···	<6.7	···	···	···	···	···
NGC 3227	1.3	1.7	14	6.6	0.7	8.5	1.0	1140	60	1940	290
2	2.9			5.5	0.4	16	1.1	1180	60	1510	80
4	4.8			4.2	0.6	20	3.0	1190	90	1470	130
NGC 3393	0.30	0.26	···	2.8	0.6	0.85	0.2	3610	60	650	130
2	0.55			2.9	0.6	1.6	0.3	3660	60	590	70

Table 6—Continued

Galaxy (1)	K-band Flux (2)	K-band Peak (3)	Brγ Peak (4)	EW(Brγ) (5)	σ_{EW} (6)	Flux (7)	σ_{Flux} (8)	cz (9)	σ_{cz} (10)	W (11)	σ_W (12)
4	1.3			3.4	0.4	4.6	0.5	3640	40	380	50
NGC 3783	1.5	1.2	9.7	13	0.6	20	0.9	2720	80	2670	110
2	2.1			15	0.6	31	1.3	2750	80	2820	100
4	3.7			9.4	0.7	35	2.5	2370	170	2610	170
NGC 4051†	0.95	2.0	14	7.3	0.7	6.9	0.6	580	70	1870	120
2	2.1			6.2	0.9	13	1.9	630	90	1870	160
4	3.0			4.0	0.6	12	1.8	780	75	1610	80
NGC 4258	0.70	0.93	···	<0.58	···	<0.42	···	···	···	···	···
2	1.6			<0.61	···	<1.0	···	···	···	···	···
4	3.7			<0.57	···	<2.2	···	···	···	···	···
NGC 4639*	1.0	···	···	···	···	···	···	···	···	···	···
2	0.96			···	···	···	···	···	···	···	···
4	2.6			···	···	···	···	···	···	···	···
Mrk 231	4.1	7.0	···	2.3	0.3	9.5	1.0	12510	70	1270	100
2	7.6			2.1	0.3	16	2.2	12500	80	1240	150
4	9.0			2.5	0.3	23	2.7	12770	150	1640	160
NGC 4945	2.5	0.61	4.9	7.0	0.3	17	0.6	464	12	352	29
2	1.6			6.5	0.3	10.7	0.5	474	11	350	34
4	4.7			7.3	0.3	34	1.3	462	10	340	27
Mrk 273†	0.073	0.10	···	11	1.7	0.8	0.1	11080	50	530	70
2	0.22			9.3	1.1	2.0	0.2	11130	50	490	50
4	0.57			5.9	0.9	3.3	0.5	11160	30	380	60
Mrk 463W	0.14	···	···	···	···	···	···	···	···	···	···
2	0.17			···	···	···	···	···	···	···	···
3	0.28			···	···	···	···	···	···	···	···
Mrk 463E	1.2	1.0	···	···	···	···	···	···	···	···	···
2	1.6			···	···	···	···	···	···	···	···
3	2.3			···	···	···	···	···	···	···	···
Circinus	1.7	12/5.8	22	3.5	0.2	5.7	0.4	430	15	270	20
2	6.6			3.5	0.2	23	1.1	428	15	185	20
3	10			3.3	0.3	33	2.6	432	25	190	15
NGC 5728†	0.19	0.13	···	5.6	1.2	1.1	0.2	2870	60	510	110
2	0.34			5.0	1.0	1.7	0.3	2870	70	530	100
4	1.1			3.0	0.8	3.3	0.9	2870	90	390	110
NGC 7469	1.2	1.7	15	10.0	0.5	12	0.6	4650	40	2020	140
2	2.6			9.7	0.5	25	1.4	4620	50	1950	190
4	4.5			8.9	0.4	40	1.9	4675	30	1150	60
Mrk 315	0.095	0.15	···	7.2	2.0	0.67	0.2	11310	150	1230	150
2	0.21			6.6	1.9	1.4	0.4	11230	160	1160	140
4	0.46			3.9	0.9	1.7	0.4	11520	110	380	80
NGC 7582(E)	1.8	1.5	9.1	5.1	0.4	9.2	0.6	1550	60	1300	100
2	3.1			5.4	0.5	17	1.4	1550	50	1360	110
4	6.9			5.9	0.5	41	3.1	1500	50	1150	140
NGC 7582(A)	2.1	3.5	18	7.7	0.4	16	0.9	1570	50	1870	130
2	4.3			7.2	0.6	31	2.7	1495	70	1650	190
4	7.4			6.7	0.5	50	3.3	1528	30	770	50

Note. — Col. (1) — Source designation. Each galaxy has three associated rows with the first corresponding to the seeing-weighted aperture spectrum, the second being to a uniform aperture 2 arcseconds in diameter, and the third corresponding to either 3 or 4 arcseconds uniform aperture. Two sets of data are listed for NGC 7582. The first are results obtained from the data taken at the ESO 2.2m telescope and the second are results of the data taken at the AAT. Col. (2) — K-band flux in 10^{-14} W m^{-2} μm^{-1}, no error estimation is quoted for this measurement since the dominant source of uncertainty is that of the flux calibration. The uncertainty in the flux calibration is $\sim$20% for all of the sources. Col. (3) — Peak K-band surface brightness in Figure 3, in units of 10^{-14} W m^{-2} μm^{-1} arcsec^{-2}. The value quoted for NGC 3393 corresponds to the KL-band measurement. For Mkn 463W and Mkn 463E only one value is given as they are both in the same field of view. The two values cited for Circinus correspond to the K- and KL-band measurements, respectively. Col. (4) — Peak Brγ surface brightness in Figure 3, in units of 10^{-18} W m^{-2} arcsec^{-2}. Col. (5) — Equivalent width of Brγ at 2.16 μm in units of Å. In case of no detection $3\,\sigma$ upper limits are given. Col. (6) — $1\,\sigma$ estimated uncertainty in the equivalent width of Brγ in Å. Col. (7) — Absolute flux of the line in units 10^{-18} W m^{-2}. For Mrk 1044, NGC 4639 and NGC 1194 (marked with asterisk), no calibration was possible. The values shown in those cases are relative to the counts measured in the 2 arcsecond aperture spectra after those spectra were normalized to unity at 2.2 μm. Values for these sources are shown in order to provide some measure of the change in flux with aperture. In case of no detection $3\,\sigma$ upper limits are given. For NGC 4639 the position of the Brγ line is at the blue limit of the spectrum so no values are given. Col. (8) — $1\,\sigma$ uncertainties estimated for the flux estimates given in Col. (7). Col. (9) — First order moment for the line in units of km s^{-1}. This provides a flux weighted estimate of the redshift without the assumption of a profile shape (such as a Gaussian). Col. (10) — $1\,\sigma$ uncertainty in the first moment. Col. (11) — Estimate of the Gaussian FWHM, Γ, derived from the second order moment using the standard relation $\Gamma = 2.355\sigma$, in units of km s^{-1}. The values have been corrected for instrumental broadening. In cases of unresolved lines, no value is given. Col. (12) — $1\,\sigma$ uncertainty in the second moment. †The absolute calibration is uncertain, since the our field-of-view is smaller than the aperture listed in Column 10 of Table 5.

Table 7. Properties of the K-band H_2 1-0 S(1) Emission Line

Galaxy (1)	Peak H_2 (2)	EW(H_2) (3)	σ_{EW} (4)	Flux (5)	σ_{Flux} (6)	cz (7)	σ_{cz} (8)	W (9)	σ_W (10)
Mrk 348	···	3.3	0.5	0.56	0.07	4360	30	300	40
2		3.1	0.4	1.2	0.2	4340	30	340	60
4		3.2	0.6	2.0	0.4	4230	40	340	70
I Zw 1	···	<0.42	···	<0.83	···	···	···	···	···
2		<0.46	···	<1.7	···	···	···	···	···
4		<0.56	···	<2.5	···	···	···	···	···
Mrk 573	···	2.7	0.4	3.1	0.5	5080	50	170	30
2		2.6	0.5	4.0	0.7	5080	90	120	20
4		2.3	0.5	7.9	1.7	5130	70	220	50
Mrk 1044*	···	<0.93	···	<0.62	···	···	···	···	···
2		<1.2	···	<1.1	···	···	···	···	···
4		<1.1	···	<1.7	···	···	···	···	···
NGC 1068†	9.9	0.66	0.09	5.1	0.7	1010	40	330	50
2		1.3	0.1	28	2.4	1052	20	310	30
4		2.6	0.1	75	4.0	1067	15	270	20
NGC 1097	···	3.0	0.5	1.1	0.2	1160	30	470	80
2		2.6	0.4	2.8	0.4	1150	40	490	80
4		1.9	0.3	5.6	1.0	1110	50	510	90
NGC 1194*	···	<0.71	···	<0.77	···	···	···	···	···
2		<1.1	···	<1.1	···	···	···	···	···
4		<0.84	···	<2.0	···	···	···	···	···
NGC 1275	53	53	1.0	15.8	0.2	5090	5	410	11
2		53	0.8	25.2	0.3	5096	5	405	10
4		40	0.9	35.7	0.7	5103	5	394	12
NGC 1365†	···	<0.38	···	<0.58	···	···	···	···	···
2		<0.44	···	<2.1	···	···	···	···	···
3		<0.48	···	<3.0	···	···	···	···	···
NGC 1386	···	2.2	0.4	1.4	0.2	780	35	280	40
2		2.0	0.3	2.0	0.3	760	25	260	40
4		1.3	0.2	3.4	0.6	680	25	240	40
NGC 1433†	···	<0.87	···	<0.14	···	···	···	···	···
2		<0.87	···	<0.26	···	···	···	···	···
4		<0.69	···	<0.56	···	···	···	···	···
NGC 1566	···	1.8	0.2	0.65	0.09	1510	30	130	20
2		1.7	0.2	2.8	0.3	1504	14	190	20
4		1.8	0.2	6.5	0.7	1490	18	140	15
NGC 1672	···	<0.45	···	<0.18	···	···	···	···	···
2		<0.35	···	<0.42	···	···	···	···	···
4		<0.39	···	<1.2	···	···	···	···	···
Mrk 1095	···	<0.57	···	<0.63	···	···	···	···	···
2		<0.56	···	<1.1	···	···	···	···	···
4		<0.57	···	<1.6	···	···	···	···	···
NGC 2110	···	3.4	0.3	0.85	0.08	2280	15	190	20
2		4.1	0.4	5.8	0.6	2270	20	280	30
4		6.1	0.7	15	1.7	2340	30	415	50
NGC 3079	···	13	0.9	22	1.3	1009	25	447	30
2		13	1.6	20	2.3	1005	30	440	50
4		13	1.1	45	3.7	1008	25	420	30
NGC 3227	14	4.6	0.3	6.0	0.4	1170	20	253	20
2		4.8	0.2	14	0.7	1170	11	245	12
4		5.4	0.2	27	1.1	1170	15	245	10
NGC 3783	···	<0.53	···	<0.82	···	···	···	···	···
2		<0.58	···	<1.2	···	···	···	···	···

Table 7—Continued

Galaxy (1)	Peak H_2 (2)	EW(H_2) (3)	σ_{EW} (4)	Flux (5)	σ_{Flux} (6)	cz (7)	σ_{cz} (8)	W (9)	σ_W (10)
4		<0.66	···	<2.4	···	···	···	···	···
NGC 4051†	···	1.9	0.2	1.8	0.2	632	30	250	30
2		2.0	0.2	4.2	0.5	612	25	210	25
4		2.2	0.2	6.7	0.7	625	20	···	···
NGC 4258	···	<0.56	···	<0.42	···	···	···	···	···
2		<0.59	···	<1.0	···	···	···	···	···
4		<0.54	···	<2.2	···	···	···	···	···
Mrk 231	20	0.69	0.1	2.8	0.6	12660	30	···	···
2		0.80	0.1	6.1	1.0	12660	30	130	20
4		1.0	0.1	9.0	1.0	12650	25	140	15
NGC 4945	24	11.9	0.3	29	0.8	458	7	261	20
2		11.1	0.3	18	0.5	458	8	258	26
4		12.3	0.3	58	1.4	458	6	260	19
Mrk 273†	8.2	20	1.8	1.4	0.1	11180	30	600	90
2		19	1.2	4.2	0.2	11150	20	580	50
4		16	1.3	9.3	0.7	11120	50	510	60
Circinus	19	2.7	0.2	4.3	0.3	445	10	265	20
2		3.6	0.2	23	1.3	450	8	···	···
3		3.5	0.2	35	2.4	448	10	···	···
NGC 5728†	···	7.3	1.0	1.5	0.2	2860	50	380	50
2		7.3	1.1	2.6	0.4	2870	40	380	60
4		6.3	0.8	7.3	1.0	2890	40	390	50
NGC 7469	5.9	2.5	0.2	3.0	0.2	4750	13	325	20
2		2.6	0.1	6.8	0.4	4735	15	285	20
4		3.2	0.1	14	0.7	4715	10	260	15
Mrk 315	2.2	<1.7	···	<0.16	···	···	···	···	···
2		<1.6	···	<0.34	···	···	···	···	···
4		3.6	0.6	1.7	0.3	11500	40	430	70
NGC 7582(E)	···	1.5	0.2	2.6	0.4	1690	30	320	60
2		1.5	0.2	4.6	0.8	1690	40	310	70
4		2.0	0.2	14	1.6	1660	30	280	60
NGC 7582(A)	3.8	1.4	0.2	2.9	0.5	1440	70	540	90
2		1.4	0.2	6.1	0.9	1490	40	410	60
4		2.2	0.2	16	1.5	1520	30	350	30

Note. — Col. (1) — Source designation. The three rows per source have the same meaning as for Table 6. Two sets of data are listed for NGC 7582. The first are results obtained from the ESO 2.2m data and the second are results from the AAT data. Col. (2) — Peak H_2 1-0 S(1) surface brightness in Figure 3, in units of 10^{-18} W m^{-2} arcsec^{-2}. Col. (3) — Equivalent width of H_2 1-0 S(1) in units of Å. In case of no detection $3\,\sigma$ upper limits are given. Col. (4) — $1\,\sigma$ estimated uncertainty in the equivalent width of H_2 1-0 S(1) in Å. Col. (5) — Absolute flux of the line in units 10^{-18} W m^{-2}. For Mrk 1044 and NGC 1194 (marked with asterisk), no calibration was possible. The values shown are relative to the counts measured in the 2 arcsecond aperture spectra after those spectra were normalized to unity at $2.2\,\mu$m. These values are shown in order to provide some measure of the change in flux with aperture. In case of no detection $3\,\sigma$ upper limits are given. Col. (6) — Uncertainties estimated for the flux estimates given in Col. (5). Col. (7) — First order moment for the line in units of km s^{-1}. Col. (8) — $1\,\sigma$ uncertainty in the first moment. Col. (9) — Estimate of the Gaussian FWHM, Γ, derived from the second order moment using the standard relation $\Gamma = 2.355\sigma$, in units of km s^{-1}. The values have been corrected for instrumental broadening. In cases of unresolved lines, no value is given. Col. (10) — $1\,\sigma$ uncertainty in the second moment. †The absolute calibration is uncertain, since the our field-of-view is smaller than the aperture listed in Column 10 of Table 6.

Table 8. H-band Flux and properties of the [FeII]1.644μm Emission Line

Galaxy (1)	H-band Flux (2)	H-band Peak (3)	[FeII] Peak (4)	EW([FeII]) (5)	σ_{EW} (6)	Flux (7)	σ_{Flux} (8)	cz (9)	σ_{cz} (10)	W (11)	σ_W (12)
I Zw 1	1.8	2.0	···	<0.56	···	<1.1	···	···	···	···	···
2	3.1			<0.57	···	<1.9	···	···	···	···	···
4	4.4			<0.57	···	<2.7	···	···	···	···	···
Mrk 1044*	0.76	···	···	<0.37	···	<0.28	···	···	···	···	···
2	1.0			<0.38	···	<0.40	···	···	···	···	···
4	1.9			<0.39	···	<0.76	···	···	···	···	···
NGC 1068	7.1	10	47	3.7	0.1	28	1.1	1089	20	625	25
2	16			4.6	0.1	76	1.7	1100	10	663	20
4	30			6.9	0.1	211	3.9	1128	10	723	20
NGC 1097	0.67	0.87	···	<0.43	···	<0.29	···	···	···	···	···
2	2.0			<0.36	···	<0.72	···	···	···	···	···
4	5.8			<0.48	···	<2.7	···	···	···	···	···
NGC 1275	0.33	0.90	20	55	1.9	18.8	0.6	5042	18	760	30
2	0.53			54	1.8	29.5	0.8	5040	20	755	30
3	0.91			42	2.0	39	1.7	5030	20	765	30
NGC 1365†	2.4	6.8	···	<0.16	···	<0.39	···	···	···	···	···
2	6.0			<0.20	···	<1.2	···	···	···	···	···
4	8.8			<0.22	···	<1.9	···	···	···	···	···
NGC 1386	0.60	0.93	7.8	6.1	0.2	3.6	0.1	880	10	470	25
2	2.2			4.6	0.1	9.9	0.3	880	9	460	20
4	5.3			2.2	0.1	11	0.5	870	12	430	30
NGC 1433†	0.40	0.31	···	<0.44	···	<0.18	···	···	···	···	···
2	0.76			<0.38	···	<0.29	···	···	···	···	···
4	2.1			<0.47	···	<0.97	···	···	···	···	···
NGC 1566	0.80	1.5	5.0	2.5	0.1	2.0	0.1	1460	11	205	10
2	2.6			1.4	0.1	3.6	0.3	1444	14	148	10
4	5.7			<0.77	···	<4.3	···	···	···	···	···
NGC 1672	0.24	0.94	···	<0.50	···	<0.12	···	···	···	···	···
2	1.9			<0.42	···	<0.78	···	···	···	···	···
4	4.8			<0.49	···	<2.3	···	···	···	···	···
Mrk 1095	1.4	6.0	···	<0.44	···	<0.62	···	···	···	···	···
2	2.4			<0.47	···	<1.1	···	···	···	···	···
4	3.6			<0.54	···	<1.9	···	···	···	···	···
NGC 2110	3.1	6.6	32	10.9	0.3	32.6	1.0	2220	7	406	13
2	1.9			14.3	0.4	26.2	0.7	2240	8	456	12
4	5.2			10.0	0.3	50.7	1.5	2220	10	388	11
NGC 3227	3.2	2.4	17	7.3	0.4	23	1.1	927	22	574	30
2	4.5			7.3	0.4	32	1.7	920	35	540	30
4	8.0			6.7	0.4	53	2.8	930	20	580	30
NGC 3783	1.0	0.82	···	1.9	0.1	1.9	0.1	2840	15	137	40
2	1.7			1.8	0.2	3.0	0.3	2840	30	117	50
4	3.5			1.4	0.2	4.9	0.6	2840	20	190	25
NGC 4051†	1.5	3.3	···	0.76	0.2	1.2	0.2	370	30	150	50
2	2.9			0.72	0.2	2.0	0.5	380	30	120	60
4	4.2			<0.54	···	<2.2	···	···	···	···	···
NGC 4945	1.3	0.61	4.5	6.2	0.2	8.3	0.3	426	9	330	22
2	1.5			6.0	0.3	9.5	0.5	429	10	334	29
4	4.4			6.4	0.2	29.3	1.0	427	10	313	30
NGC 7469	2.3	5.6	9.7	1.7	0.2	3.7	0.4	4760	25	350	35
2	4.3			2.1	0.2	8.8	0.9	4750	15	290	30
4	6.8			2.9	0.2	19	1.1	4754	11	290	16
NGC 7582(A)	2.0	7.8	5.1	2.5	0.1	5.1	0.2	1617	12	265	10
2	4.2			2.7	0.1	11.5	0.4	1614	10	288	10

Table 8—Continued

Galaxy (1)	H-band Flux (2)	H-band Peak (3)	[FeII] Peak (4)	EW([FeII]) (5)	σ_{EW} (6)	Flux (7)	σ_{Flux} (8)	cz (9)	σ_{cz} (10)	W (11)	σ_W (12)
4	9.4			3.5	0.1	33.6	1.1	1603	10	336	10

Note. — Col. (1) — Source designation. The three rows per source have the same meaning as for Table 6. Col. (2) — H-band flux in 10^{-14} W m^{-2} μm^{-1}. No error estimation is quoted for this measurement since the dominant sources of uncertainty is that of the flux calibration. The uncertainty in the flux calibration is ∼20% for all of the sources. Col. (3) — Peak H-band surface brightness in Figure 3, in units of 10^{-14} W m^{-2} μm^{-1} arcsec^{-2}. The values quoted for NGC 4945, NGC 7469, and NGC 7582 correspond to the HH-band measurement. Col. (4) — Peak [FeII]λ1.644μm surface brightness in Figure 3, in units of 10^{-18} W m^{-2} arcsec^{-2}. Col. (5) — Equivalent width of the [FeII]λ1.644μm emission line in units of Å. In case of no detection 3σ upper limits are given. Col. (6) — 1σ estimated uncertainty in the equivalent width of [FeII]λ1.644μm in Å. Col. (7) — Absolute flux of the line in units 10^{-18} W m^{-2}. For Mrk 1044 no calibration was possible. The values shown are relative to the counts measured in the 2 arcsecond aperture spectrum after it was normalized to unity at 2.2μm and the continuum was then extrapolated to the H-band. These values are shown in order to provide some measure of the change in flux with aperture and for allowing the comparison of features in the H- and K-band in Mrk 1044. In case of no detection 3σ upper limits are given. Col. (8) — Uncertainties estimated for the fluxes given in Col. (7). Col. (9) — First order moment for the line in units of km s^{-1}. This provides a flux weighted estimate of the redshift without the assumption of a profile shape (such as a Gaussian). Some of the line profiles were apparently contaminated by absorption from the adjacent CO bandhead. Where this occurs it did not appear to significantly change the flux, EQW, or the redshift estimates for the strongest lines. Col. (10) — 1σ uncertainty in the first moment. Col. (11) — Estimate of the second order moment in units of km s^{-1}. The values have been corrected for instrumental broadening. Col. (12) — 1σ uncertainty in the second moment. †The absolute calibration is uncertain, since the our field-of-view is smaller than the aperture listed in Column 10 of Table 5.

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